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Effects of water exercise swimming program on aquatic skills and social behaviors in children with autism spectrum disorders

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ABSTRACT The purpose of this study was to determine the effectiveness of a 10 week water exercise swimming program (WESP) on the aquatic skills and social behaviors of 16 boys with autism spectrum disorders (ASDs). In the first 10 week phase (phase I), eight children (group A) received the WESP while eight children (group B) did not. A second 10 week phase (phase II) immediately followed, with the treatments reversed. Both groups continued their regular treatment/activity throughout the study. Improvements were seen in aquatic skills for both groups subsequent to the WESP. Following phase I, significant social improvements were seen in group A. Following phase II, social improvements were seen for group B, whereas group A merely maintained the improvements they attained through the implementation of the WESP during phase I. Results indicate that the WESP improved aquatic skills in the participants, and holds potential for social improvements.

KEYWORDS *adapted aquatics; autism spectrum disorders; swimming*

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Introduction

Characteristics of autism spectrum disorders (ASDs) typically include limited spontaneous language and play, an inability to sustain conversations, and difficulty in processing social messages and cues that promote socially appropriate behaviors (American Psychiatric Association, 2000). The nature of ASDs presents a challenge not only to children with this disability, but also to teachers and parents in fostering the development of social behaviors. Despite these challenges, a number of promising interventions for building critical skills have been developed, and the importance of social

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relationships for this population is increasingly being acknowledged (McConnell, 2002). Examples of successful interventions include: (1) a structured teaching model known as Treatment and Education of Autistic and Related Communication-Handicapped Children (TEACCH: Blubaugh and Kohlmann, 2006); (2) priming with adult teaching and peer mediation to increase initiation (Morrison et al., 2001); and (3) the use of environments established for intervention to increase spontaneous communication (Prendeville et al., 2006).

Physical activity is an important part of a healthy lifestyle for all people (US Department of Health and Human Services, 1996), but there is relatively little information regarding physical activity in individuals with ASDs. Pan and Frey (2006) used an accelerometer to examine physical activity in American youth with ASDs aged 10–19, and found that youth with ASDs were less active than described in previous reports on peers without disabilities (Trost et al., 2002). In addition, physical activity declined with age and some youth with ASDs did not accumulate the recommended daily 60 minutes of moderate-to-vigorous physical activity (MVPA). Pan (2008) compared the percentage of time children with and without ASDs spent in MVPA during inclusive recess settings in Taiwan, and found that children with ASDs were less active during overall recess, lunchtime, and first and second morning recess compared to those without disabilities. The result of this study (Pan, 2008) also indicated that all children did not achieve 40 percent of recess time in physical activity. It appears that youth with ASDs are at similar risk for being physically inactive as those without disabilities. Since the number of individuals being diagnosed with ASDs is widely increasing (Ministry of Education, 2006; Wing and Potter, 2002), there is a need to identify modes or types of recreational activity to increase physical activity with these children.

Although not specific to swimming, two studies have reported positive physical and behavior effects for children with ASDs when involved in regimens that increased their physical activity. Pitetti et al. (2007) examined the efficacy of a 9 month treadmill walking (TW) program on exercise capacity and body mass index (BMI) for adolescents with severe autism. The authors observed significant increases in mean monthly TW frequency, speed, elevation, and calories expended as well as a reduction in BMI. Rosenthal-Malek and Mitchell (1997) assessed the effects of aerobic exercise on the self-stimulatory behaviors and academic performance of adolescents with ASDs. A significant decrease in self-stimulatory behavior and increase in the level of correct responding as well as an increase in the completion of the number of tasks were found. In light of these results, more research is warranted to look at the effects of physical activity interventions on individuals with ASDs.

In regard to swimming, Attwood (1998) suggested the ability to swim was less affected in children with ASDs than were other physical activities. He also suggested swimming can enhance a child's competence and foster an appreciation of proficient movement. Aquatic activity exercises the total body without putting excessive stress or tension on specific body parts (Becker and Cole, 2004). The warm aquatic environment and splashing enhance normal muscle tone, allowing more efficient movement (Becker and Cole, 2004). Buoyancy enables initiation of independent movement possibilities that are difficult to achieve on land due to gravitational restraints (Hutzler et al., 1998).The therapeutic use of water activities or swimming in children with ASDs is believed to facilitate language development and self-concept (Best and Jones, 1972; Hamilton, 1972), and to improve adaptive behavior and provide an appropriate setting for early educational intervention (Bachrach et al., 1978).

Two recent swimming interventions for individuals with ASDs have been reported. Yilmaz et al. (2004) investigated the effectiveness of a 10 week water exercises and swimming program on the motor performance and physical fitness of a 9-year-old child with ASDs. The water orientation and beginner swimming skills assessment was performed before and after 10 weeks training. The result of this study (Yilmaz et al., 2004) indicated that the 10 week swimming program improved the child's balance, agility, lower and upper extremity muscle strength and cardiovascular fitness. In addition, the child experienced a reduction in stereotypic autistic movements (e.g. spinning, rocking, and delayed echolalia). Huettig and Darden-Melton (2004) examined the acquisition of aquatic skills by four children aged 7–13 with autism. The aquatic skills were assessed initially and subsequently throughout the study. The results showed that each of the children with autism demonstrated remarkable improvements in swimming skills during the intervention period. Particularly impressive were dramatic gains in the acquisition of swimming stroke skills. Two of the mothers reported their whole family had been able to participate in swimming for the first time. One child was learning to water ski, and the other child was swimming with the families at the local pool and camping/swimming at a lake after the program.

Since one of the core characteristics of ASDs is difficulties in social interaction and communication (American Psychiatric Association, 2000) and physical activity intervention is often overlooked in this population, the aim of this study was to understand the effects of a water exercise swimming program (WESP) with a social skills component on the aquatic skills and social behaviors of children with ASDs. If a WESP does have important effects on social behaviors as well as aquatic skills, then compelling arguments for the inclusion of physical activity treatment components targeting social

skills could be made. The present study used a controlled, single-blind design to evaluate the effect of a 10 week WESP on the aquatic skills and social behaviors of children with ASDs. It was hypothesized that the WESP would improve both aquatic skills and social behaviors in this population.

Method

Experimental design

A within-participant repeated-measures design was adopted. Each participant was assessed three times, once at study entry to serve as the baseline (T1), a second time after 10 weeks of WESP or regular treatment/activity (T2), and a third time after another 10 weeks (T3). The order of assessments, except for the baseline, was counterbalanced between two groups of participants. This was accomplished by dividing the participants into two groups of equal size and disability type. Group A received the WESP in the first phase of 10 weeks and the second assessment after the WESP and then regular treatment/activity and third assessment. The arrangement of treatment was reversed in group B participants. Therefore, the whole study program was 21 weeks, with 10 weeks WESP, 10 weeks control, and 1 week transition.

Participants

Participants with ASDs were diagnosed through medical and psychological assessment by experienced and knowledgeable physicians in the public hospitals (Executive Yuan, 2006a). They were identified as meeting the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 1994) criteria for autism. Diagnoses included mild or high-functioning autism ($n = 8$) and Asperger syndrome ($n = 8$). Level of severity (mild, moderate, severe, and very severe) is based on functioning in the social adaptive skill areas and language comprehension and expression (Executive Yuan, 2006b). Inclusion criteria for participants in this study were (1) a diagnosis of mild ASD or Asperger syndrome, (2) age from 6 to 9 years old, (3) able to follow instructions, and (4) parental commitment to allow participation without changing current therapy or activity. Individuals with intellectual disability as a co-occurring condition were excluded.

All participants attended inclusive schools and were assigned to the resource room on a regularly scheduled basis to receive special education services while continuing their other studies in regular classrooms during most of each school day. In addition, some of the participants regularly received after-school occupational therapy ($n = 6$), physical therapy ($n = 2$), group therapy ($n = 3$), and speech therapy ($n = 1$). After-school occupational

therapy consisted of fine motor function, sensory integration, and activity of daily living training; physical therapy included passive range of motion exercises, positioning, balance training, functional training, and neurodevelopment training; speech therapy involved language comprehension, expression, and communication training; and group therapy involved speaking freely in a group, giving feedback to others, learning others' way of interaction, and asking for support. Four were enrolled in an inclusive community-based physical activity program (Tae Kwon Do, $n = 2$; in-line skating, $n = 2$). Two manifested diagnosed associated conditions such as attention deficit disorder and were on medication (Ritalin) to relieve symptoms. None had multiple co-occurring conditions or gross motor difficulties. All reside in urban settings and live in a two-parent household.

Regarding prior swimming experience, six children had participated in weekly pool instruction with children without disabilities during the summer (ranging from seven to 20 sessions, 45–90 min each) prior to this study, and were evenly distributed between the two groups. All participants had very limited breathing, floating, and stroke skills based on parent reports and first assessment at study entry. The majority of participants ($n = 14$) had accomplished the mental adjustment stage with no fear of the water.

Consent forms were obtained from all the parents and children prior to enrollment in the study. The study was approved by the university human subjects review board. All children completed the whole 21 week program (10 weeks WESP, 10 weeks control, and 1 week transition). Descriptive characteristics are found in Table 1.

Water exercise swimming program

Before the study began, a workshop was held to introduce the WESP to all parents, children with ASDs, and research assistants. Four of the research assistants served as swimming instructors and had completed a WESP training course prior to the study. During each WESP session, two children with ASDs were paired up with the same instructor for each session. The 10 week WESP intervention consisted of 20 sessions (two sessions per week, 90 minutes per session) at a local indoor hydrotherapy and swimming pool in Kaohsiung city, Taiwan. Each session was divided into four categories: (A) social and floor warm-up activities, (B) one-to-two small group instruction, (C) whole group games/activities, and (D) cool-down activities. The WESP category, content, and motor and social goals are outlined in Table 2.

The WESP design was based on the Humphries Assessment of Aquatic Readiness (HAAR: Humphries, 2008) assessment instruction developed according to the foundations of the Halliwick Method (Martin, 1981). The Halliwick Method utilizes the natural progression of the way humans acquire

Table 1 **Participant descriptive characteristics**

	Age (years)	*Height (cm)*	*Weight (kg)*	*BMI (kg/m^2)*	*Type of ASD*
Group A					
P 1	7.42	127.00	22.50	13.95	HFASD
P 2	7.33	130.60	33.40	19.58	HFASD
P 3	7.17	128.00	43.60	26.61	HFASD
P 4	5.58	120.00	27.50	19.10	HFASD
P 5	9.75	141.40	42.40	21.21	Asperger
P 6	7.75	130.60	23.50	13.78	Asperger
P 7	7.17	135.40	30.40	16.58	Asperger
P 8	6.00	117.00	21.00	15.34	Asperger
M ± *SD*	7.27 ± 1.25	128.75 ± 7.83	30.54 ± 8.73	18.27 ± 4.32	
Group B					
P 9	8.17	124.40	25.50	16.48	HFASD
P 10	7.33	122.00	24.50	16.46	HFASD
P 11	6.42	123.00	22.00	14.54	HFASD
P 12	6.42	118.40	18.50	13.20	HFASD
P 13	8.58	132.60	36.20	20.59	Asperger
P 14	7.58	124.00	24.00	15.61	Asperger
P 15	7.00	126.00	22.00	13.86	Asperger
P 16	6.08	125.00	32.00	20.48	Asperger
M ± *SD*	7.20 ± 0.89	124.43 ± 4.04	25.59 ± 5.77	16.40 ± 2.80	

ASD = autism spectrum disorders; HFASD = high-functioning autism spectrum disorders.

physical movements. It is rooted more in the biomechanical principles associated with the aquatic environment than in a learn-to-swim progression. Structured teaching, the most crucial and recognizable feature of the TEACCH model (Mesibov et al., 2004), was also utilized in the program, including organization of the physical environment (e.g. establish clear boundary markings to help children know where they may and may not go) and visual schedules and work systems (e.g. a board with pictures and words to describe the routine and the daily WESP activity).

The WESP was implemented in a one-to-two instructor-to-student ratio, which allowed for individual instruction. The instructor was able to follow the progression of the method with the student at his own pace, and also to teach and take into consideration challenges or factors associated with the student's disability and the environment (the water, the goals of the program, and the functional aspects of the skills that have been determined to be taught). The WESP also provides games and group activities that are specific to the principles of the method at the end of each session. As the student worked to gain independence in the water, he was also able

Table 2 **Water exercise swimming program protocol**

Category	*Length (min)*	*Content*	*Goal*
A. Floor activities	20	Visual schedules and social activities Limbs and truck exercise Splashes water with hand or foot	Communication and social interaction Warm-up Water adjustment
B. One-to-two instruction	40	Water orientation skills Breathing skills Floating skills Stroke skills	Water orientation and swimming skills
C. Group activities	20	Cooperative games/ activities (e.g., noodle kick/jump/float, hula-hoop swimming)	Social interaction Aquatic and motor skill development
D. Cool down activities	10	Look at the primary instructor, listen, raise hand if there is a question or want to answer a question	Review, reward, social interaction, clean-up, and help with transition

to become a part of the class while maintaining the one-to-two instructional setting. The student was able to take advantage of social interaction with his peers and yet still benefit from the constant attention of his own personal instructor. The WESP was implemented as prescribed and supervised by the researcher each session.

Measurement of aquatic skills and social behaviors

Both aquatic skill measures and social behavior ratings were collected three times, once at study entry to serve as the baseline (T1), a second time after 10 weeks of WESP or regular treatment/activity (T2), and a third time after another 10 weeks (T3). Measurements were collected and supervised by the research assistants and the researcher, each of whom was involved in the development of the study methodology (e.g. instructions for measurements).

Aquatic skills The HAAR checklist was used to assess each participant's aquatic skills. It is designed based on the Halliwick Method (Martin, 1981) which has been reported to be safe for people of all ages and with many types of disabilities (MacKinnon, 2003). The HAAR demonstrates face validity and a high degree of inter-rater reliability (above 0.90) (Humphries,

2008). It is divided into five stages: (I) mental adjustment (five items), (II) introduction to water environment (10 items), (III) rotations (three items), (IV) balance and control (eight items), and (V) independent movement in water (six items). Items in each stage of HAAR are shown in Table 3.

The administration procedures were as follows. Each child was in the water with his instructor, while the researcher was out of the water and nearby. The researcher told the instructor the nature of each skill and the child was assessed according to his performance of each specific skill. Inter-observer reliability data have been collected on each of the 16 participants in each of the three test periods by two trained undergraduate students and the researcher. It was calculated by dividing agreements by agreements plus disagreements and multiplying by 100 for each stage. Results showed a high level of inter-observer agreement (all above 0.90).

Social behaviors Social behaviors were rated by the child's school classroom teacher using the School Social Behavior Scales (SSBS–2: Merrell, 2002). All classroom teachers were blind to the children's treatment conditions when making the assessment. The SSBS–2 was used to assess both social competence (peer relations, self-management/compliance, academic behavior) and antisocial behavior (hostile/irritable, antisocial/aggressive, defiant/disruptive). It is a norm-referenced, standardized instrument developed for use by teachers and other school-based raters for children grades K–12. The raw score for peer relations and hostile/irritable ranged from 14 to 70, for self-management/compliance and antisocial/aggressive from 10 to 50, for academic behavior and defiant/disruptive from 8 to 40. For the social competence scale, higher scores indicate greater levels of social adjustment; and for the antisocial behavior scale, higher scores indicate greater levels of social behavior problems. The raw scores are added to arrive at a social competence total and an antisocial behavior total, both ranging from 32 to 160. Each raw score can be converted into a *T*-score and percentile ranks to determine an individual's social behavior performance.

The SSBS–2 evidences a high degree of reliability for internal consistency (all above 0.90) and 1 week test–retest reliability (all above 0.85) for the two major scales and the six subscales (Merrell, 2002). The test also demonstrates content validity, criterion-related validity, construct validity, and discriminative validity (Merrell, 2002).

Data analysis

The primary analysis was to compare the children's performance under WESP treatments and under regular treatments/activities. First, changes in dependent variables (percentage scores in each stage for aquatic skills and *T*-scores for social behaviors) were examined in relation to treatment

Table 3 **Humphries' Assessment of Aquatic Readiness (HAAR) checklist**

Stage I: Mental adjustment	*Stage II: Introduction to water environment*	*Stage III: Rotations*	*Stage IV: Balance and controlled movement*	*Stage V: Independent movement in water*
__Will play with toy on pool deck __Will sit on the steps of the pool __Will enter/exit the pool by instructor carrying them __Will enter/exit the pool by holding the instructor's hand __Will enter/exit the pool without holding the instructor's hand Score: ___/5 Percentage: ___%	__Will splash water with hands with the instructor's support __Will splash water with hands without the assistance from the instructor __Will touch chin to water __Will touch ear to water __Will touch mouth to water __Will blow bubbles in water __Will perform shipping action with mouth __Will allow water to be poured on head __Will place head in water __Will place head in water independently and come up with minimal water consumption Score: ___/10 Percentage: ___%	__Will perform a vertical/forward rotation (roll from supine position to standing position in the pool) __Will perform a lateral rotation (roll from supine position to prone position and back to supine) __Will perform a combined rotation (go from standing in the water to prone position and then rotate to supine position Score: ___/3 Percentage: ___%	__Will reach from standing position for toy on first pool step without assistance __Will reach from standing position for toy on tot dock or from the bottom of the pool without assistance __Will allow the instructor to move them passively through the water in the prone position __Will allow the instructor to move them passively through the water in the supine position __Will kick legs with instructor's support __Will move arms in rudimentary pattern with instructor's support __Will move arms with straight over arm motion with instructor's support __Will kick legs with straight pattern with instructor's support Score: ___/8 Percentage: ___%	__Will float supine unassisted __Will glide from side of pool to instructor independently __Will glide with bent leg kick to instructor independently __Will glide with straight leg kick to instructor independently __Will come to instructor with straight leg kick and rudimentary arm movements independently __Will come to instructor with straight leg kick and straight over arm independently Score: ___/6 Percentage: ___%

Source: Humphries (2008), p. 22.

(experimental or control program), using a two-way ANOVA (group × time) with repeated measures on one factor (time: T1 versus T2). For those with interactions, a least significant difference (LSD) *post hoc* test was used to further analyze the treatment effect (WESP) under different conditions. The effect size was also calculated to evaluate the amount of variance accounted for by the WESP.

The second analysis was to examine the treatment effect in group B (T2 versus T3) by paired *t*-test. For group B, T1 and T2 were the regular treatments/activities. Both were pre-WESP, just like T1 of group A. If T1 and T2 did not differ on the dependent measures, T2 would be included as the pre-WESP regular treatment because it is closer in time to the WESP treatment condition. On the other hand, if T1 and T2 differed substantially on many dependent measures, then the average of T1 and T2 would be used. The latter procedures were established in order to control for possible developmental effect or effect of regular treatment/activity.

The third analysis was to examine the difference between T2 and T3 in group A by paired *t*-test. This analysis was deemed necessary because T3 was post-WESP and therefore the analysis essentially detected whether a potential WESP treatment effect could be sustained after the treatment had been discontinued. All statistical analyses were conducted with SPSS version 13.0 for Windows. To control for possible type I error inflation due to multiple comparisons by repeated-measures ANOVA and paired *t*-tests, the alpha level was set at $p < 0.01$.

Results

Effectiveness of WESP on aquatic skills

Results for aquatic skills are found in Table 4. There were no differences between groups at study entry.

The primary analysis revealed a significant main effect of time on all stages except for stage I, indicating a larger improvement of score after the WESP (Table 5). No significant group differences existed in any of the stages. A significant interaction effect was also observed for all stages except stage I.

Group A Group A had a significantly higher score after the WESP (T2) as compared to T1 (stage II, $t = 13.13$, d.f. $= 7$, $p < 0.01$; stage III, $t = 3.74$, d.f. $= 7$, $p < 0.01$; stage IV, $t = 8.28$, d.f. $= 7$, $p < 0.01$; stage V, $t = 9.73$, d.f. $= 7$, $p < 0.01$; total aquatic skills, $t = 14.47$, d.f. $= 7$, $p < 0.01$). The comparison between T2 and T3 for group A showed no significant difference on any of the percentage scores of each stage. In addition, a significantly

Table 4 **Percentage scores on Humphries' Assessment of Aquatic Readiness (HAAR) checklist**

HAAR stage	*Stage I: Mental adjustment*			*Stage II: Introduction to water*			*Stage III: Rotations*			*Stage IV: Balance and controlled movement*			*Stage V: Independent movement in water*		
	T1	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*
Group A															
P 1	100	100	100	70	100	100	0	66.7	66.7	25	75	75	0	66.7	66.7
P 2	100	100	100	50	90	90	0	33.3	33.3	37.5	75	75	0	66.7	66.7
P 3	100	100	100	70	100	100	0	66.7	66.7	37.5	75	75	0	66.7	66.7
P 4	80	100	100	30	70	60	0	0	0	12.5	75	75	0	50	50
P 5	100	100	100	50	100	100	0	33.3	33.3	25	75	75	0	66.7	66.7
P 6	100	100	100	30	80	80	0	33.3	33.3	25	62.5	62.5	0	66.7	66.7
P 7	100	100	100	60	100	100	0	33.3	33.3	25	100	100	0	100	100
P 8	80	100	100	50	80	60	0	0	0	12.5	37.5	37.5	0	33.3	33.3
Mean	95.00	100.00	100.00	51.25	90.00	86.28	0.00	33.33	33.33	25.00	71.88	71.88	0.00	64.60	64.60
SD	(9.26)	(0.00)	(0.00)	(15.53)	(11.95)	(17.68)	(0.00)	(25.21)	(25.21)	(9.45)	(17.36)	(17.36)	(0.00)	(18.78)	(18.78)
Group B															
P 9	100	100	100	30	30	70	0	0	0	12.5	25	50	0	0	33.3
P 10	100	100	100	70	70	90	0	0	0	12.5	25	62.5	0	0	33.3
P 11	100	100	100	70	70	100	0	0	33.3	37.5	37.5	75	33.3	33.3	66.7
P 12	100	100	100	70	70	100	33.3	33.3	66.7	50	62.5	100	33.3	33.3	83.3
P 13	100	100	100	60	60	100	0	0	33.3	37.5	50	87.5	0	0	66.7
P 14	100	100	100	50	50	70	0	0	0	12.5	12.5	50	0	0	33.3
P 15	100	100	100	60	60	100	0	0	33.3	37.5	37.5	75	0	0	66.7
P 16	100	100	100	60	60	70	0	0	0	12.5	12.5	50	0	0	33.3
Mean	100.00	100.00	100.00	58.75	58.75	87.50	4.16	4.16	20.83	32.81	32.81	68.75	8.33	8.33	52.08
SD	(0.00)	(0.00)	(0.00)	(13.56)	(13.56)	(14.88)	(11.77)	(11.77)	(24.80)	(17.60)	(17.60)	(18.90)	(15.41)	(15.41)	(20.79)

Table 5 **The HAAR results of two-way (group × time) ANOVA with repeated measures on one factor (time)**

Variables	*F*	*p*	*Partial eta*^{2}	*Observed power*
Stage I				
Group (G)	2.33	0.15	0.14	0.30
Time (T)	2.33	0.15	0.14	0.30
G × T	2.33	0.15	0.14	0.30
Stage II				
Group (G)	3.15	0.10	0.18	0.38
Time (T)*	172.49	0.00	0.93	1.00
G × T*	172.49	0.00	0.93	1.00
Stage III				
Group (G)	4.20	0.06	0.23	0.48
Time (T)*	13.98	0.00	0.50	0.94
G × T*	13.98	0.00	0.50	0.94
Stage IV				
Group (G)	4.43	0.05	0.24	0.50
Time (T)*	68.48	0.00	0.83	1.00
G × T*	68.48	0.00	0.83	1.00
Stage V				
Group (G)*	14.12	0.00	0.50	0.94
Time (T)*	94.69	0.00	0.87	1.00
G × T*	94.69	0.00	0.87	1.00
HAAR Total				
Group (G)	7.09	0.02	0.34	0.70
Time (T)*	209.28	0.00	0.94	1.00
G × T*	209.28	0.00	0.94	1.00

* notes significance at $p < 0.01$.

higher score for aquatic skills occurred in group A at T2 as compared to T2 in group B (stage II, $t = 4.89$, d.f. $= 14$, $p < 0.01$; stage III, $t = 2.99$, d.f. $= 14$, $p < 0.01$; stage IV, $t = 4.47$, d.f. $= 14$, $p < 0.01$; stage V, $t = 6.55$, d.f. $= 14$, $p < 0.01$; total aquatic skills, $t = 5.91$, d.f. $= 14$, $p < 0.01$) (Figure 1).

Group B The comparison between T2 and T3 for group B showed significant difference on stage II ($t = -7.22$, d.f. $= 7$, $p < 0.01$), stage IV ($t = -23.00$, d.f. $= 7$, $p < 0.01$), stage V ($t = -8.09$, d.f. $= 7$, $p < 0.01$), and total aquatic skills ($t = -10.94$, d.f. $= 7$, $p < 0.01$). There were no differences between T1 and T2 for group B on all stages.

Effectiveness of WESP on social behaviors

Results for social behaviors are found in Table 6. There were no differences between groups at study entry. Analysis of variance revealed a significant main effect of time on the academic behavior and all antisocial behaviors

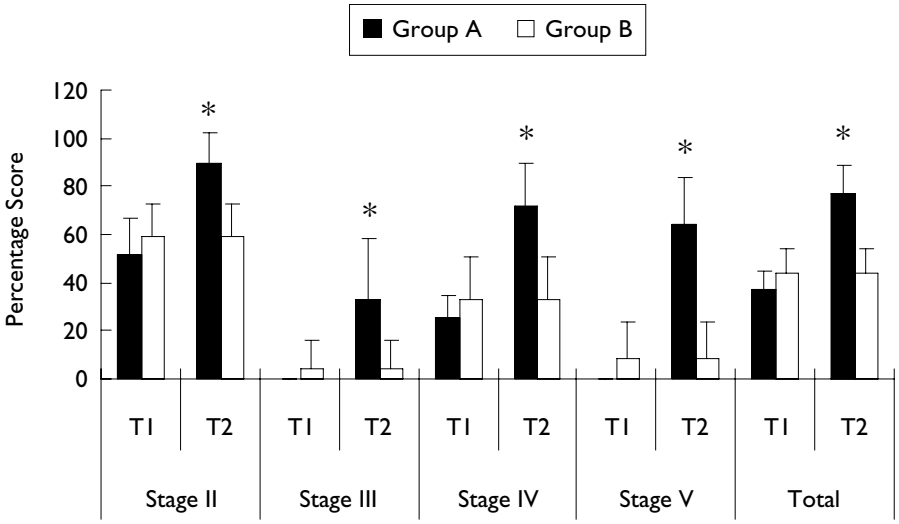

Figure 1 **The HAAR percentage score of two groups of children with ASD before and after the WESP; * Denotes significantly different from group B (T1 and T2) and group A (T1) at $p < .01$.**

(Table 7). None of the items showed any significant main effects of group or group × time interaction.

Group A Group A had a significantly higher score on academic behavior ($t = 6.86$, d.f. $= 7$, $p < 0.01$) and a significantly lower score on hostile/irritable ($t = -6.99$, d.f. $= 7$, $p < 0.01$), antisocial/aggressive ($t = -4.40$, d.f. $= 7$, $p < 0.01$), defiant/disruptive ($t = -7.07$, d.f. $= 7$, $p < 0.01$) and antisocial behavior total ($t = -7.88$, d.f. $= 7$, $p < 0.01$) at T2 as compared to T1. A significantly higher score between T2 and T3 was only found on hostile/irritable behavior ($t = -3.69$, d.f. $= 7$, $p < 0.01$).

Group B There was a significant difference on social competence total ($t = 6.24$, d.f. $= 7$, $p < 0.01$) at T3 as compared to T2. Group B also had a lower score on hostile/irritable ($t = -4.71$, d.f. $= 7$, $p < 0.01$) and antisocial behavior total ($t = -3.95$, d.f. $= 7$, $p < 0.01$) after the WESP (T3) as compared to T2.

Discussion

Previous studies have demonstrated improvements in swimming and behavior skills as a result of a swimming program (Bachrach et al., 1978; Best and Jones, 1972; Hamilton, 1972; Huettig and Darden-Melton, 2004; Yilmaz

Table 6 ***T*-score and percentile rank on social competence and antisocial behavior**

	Group A						*Group B*					
	T-Score			*Percentile rank*			*T-score*			*Percentile rank*		
	T1	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*	*T1*	*T2*	*T3*
PR	41.50 (4.17)	43.88 (4.92)	45.50 (5.45)	25.00 (11.70)	31.88 (15.39)	37.00 (17.28)	43.00 (4.57)	41.63 (5.26)	47.13 (3.44)	29.50 (13.17)	25.63 (16.14)	42.13 (11.05)
SM	44.13 (2.17)	47.13 (4.88)	46.38 (6.57)	31.25 (6.32)	39.50 (13.96)	38.13 (17.96)	44.38 (3.74)	45.13 (4.32)	50.75 (4.46)	31.75 (10.66)	33.75 (11.95)	50.00 (13.20)
AB	45.88 (2.30)	51.38 (2.20)	50.38 (2.45)	36.88 (6.42)	53.38 (6.59)	50.25 (7.27)	45.25 (6.30)	48.50 (4.21)	52.75 (4.03)	30.00 (12.93)	45.88 (12.88)	57.75 (11.67)
SC total	42.67 (3.02)	46.25 (3.99)	46.50 (5.07)	27.75 (8.83)	38.63 (12.25)	39.25 (15.36)	43.38 (4.31)	43.88 (3.48)	49.63 (3.11)	30.00 (12.93)	31.50 (10.82)	49.25 (9.27)
HI	60.38 (5.24)	46.25 (5.18)	53.25 (7.72)	82.00 (10.57)	46.38 (17.98)	65.63 (19.08)	60.75 (6.20)	53.25 (7.89)	43.75 (2.92)	82.25 (10.38)	65.88 (19.22)	38.50 (12.98)
AA	52.00 (3.30)	45.00 (4.44)	48.75 (5.73)	69.63 (6.35)	47.75 (14.45)	59.88 (16.06)	56.00 (7.60)	48.75 (7.07)	44.75 (2.76)	75.75 (11.73)	58.25 (18.90)	48.50 (9.96)
DD	59.50 (5.15)	45.88 (6.47)	51.75 (8.19)	80.63 (8.83)	46.63 (18.12)	62.63 (19.83)	58.63 (7.41)	51.63 (7.23)	45.00 (4.54)	77.75 (12.66)	63.13 (17.23)	46.75 (12.58)
AnB total	58.00 (4.17)	45.75 (5.44)	51.63 (7.35)	77.38 (8.47)	43.75 (19.13)	61.75 (18.13)	59.38 (6.93)	51.75 (7.38)	44.00 (2.73)	78.75 (12.24)	62.13 (18.22)	40.00 (11.98)

PR = peer relations; SM = self-management/compliance; AB = academic behavior; SC = social competence; HI = hostile/irritable; AA = antisocial/aggressive; DD = defiant/disruptive; AnB = antisocial behavior.

Table 7 **The social competence and antisocial behavior measures (*T*-scores) of two-way (group x time) ANOVA with repeated measures on one factor (time)**

Variables	*F*	*p*	*Partial eta*^{2}	*Observed power*
PR				
Group (G)	0.03	0.86	0.00	0.05
Time (T)	0.17	0.69	0.01	0.07
G × T	2.39	0.15	0.15	0.30
SM				
Group (G)	0.29	0.60	0.02	0.08
Time (T)	3.01	0.11	0.18	0.37
G × T	1.08	0.32	0.07	0.16
AB				
Group (G)	0.87	0.37	0.06	0.14
Time (T)*	27.93	0.00	0.67	1.00
G × T	1.85	0.20	0.12	0.25
SC total				
Group (G)	0.26	0.62	0.02	0.08
Time (T)	4.96	0.04	0.26	0.55
G × T	2.83	0.12	0.17	0.35
HI				
Group (G)	2.23	0.16	0.14	0.29
Time (T)*	32.62	0.00	0.70	1.00
G × T	3.06	0.10	0.18	0.37
AA				
Group (G)	2.33	0.15	0.14	0.30
Time (T)*	23.23	0.00	0.62	0.99
G × T	0.01	0.93	0.00	0.05
DD				
Group (G)	0.73	0.41	0.05	0.13
Time (T)*	37.82	0.00	0.73	1.00
G × T	3.90	0.07	0.22	0.45
AnB total				
Group (G)	1.97	0.18	0.12	0.26
Time (T)*	40.41	0.00	0.74	1.00
G × T	2.19	0.16	0.14	0.28

* Denotes significance at $p < 0.01$; PR = peer relations; SM = self-management/compliance; AB = academic behavior; SC = social competence; HI = hostile/irritable; AA = antisocial/aggressive; DD = defiant/disruptive; AnB = antisocial behavior.

et al., 2004). In the present study, children with ASDs underwent a 10 week swimming program in order to determine its effect on swimming, behavioral, and social skills. Results indicate that the WESP improved the aquatic skills in four out of five stages as measured with percentage scores, and decreased the total antisocial behavior problems in children with ASDs. The results also showed that such improvement of the majority of scores was not different between two groups of children with ASDs. Further, the effect

of the WESP showed sustainability for at least 10 weeks as demonstrated by lack of a statistically significant difference between T2 and T3 on each HAAR stage and social behavior in group A, when the group A participants returned to their regular treatment/activity.

The effect of the WESP on aquatic skills in the current study is similar to the findings of two previous studies (Huettig and Darden-Melton, 2004; Yilmaz et al., 2004). Huettig and Darden-Melton (2004) found that children with ASDs showed improvement in scores on water orientation skills, breathing skills, floating skills, stroke skills, and entry and exit skills over an extended period of program. Yilmaz et al. (2004) indicated that the balance, speed, agility and power scores of children with ASDs increased after 10 weeks swimming training. The increment of scores ranged from 8.36 to 33.19 seconds, 1.59 seconds, 3 points, and 6 cm for balance, speed, agility, and power, respectively. The hand grip, upper and lower extremity muscle strength, flexibility and cardio-respiratory endurance also increased. In the current study, group A showed a significantly larger improvement after the WESP. The increment of scores ranged from 33.33 to 64.60 percent, and the effects lasted for 10 weeks after the WESP. Group B also showed a significantly larger improvement after the WESP (ranging from 28.75% to 43.75%). One possible explanation for these similarities is that curriculum-based assessment served as the basis for the instructional process of the aforementioned research and the current study. The WESP starts with a mental adjustment to the activity and the factors associated with it. As the program progressed, more dynamic and challenging tasks were added, including rotations, balance and controlled movement, and independent movement in water. Another reason may be that the WESP was carefully designed based on number of variables including the child's age, disability, experiences on the water, play skills, and interests and needs of the family. Lesson plans were also carefully prepared and reviewed. Therefore, the potential positive impacts of the program were maximized.

In this study, participant 7 of group A made the most progress on the total aquatic skills. The HAAR total percentage score improved from 40.63 to 93.75. During the post-WESP period, the total percentage score was retained. Participant 7 was a boy with Asperger syndrome aged 7 years 2 months. Before the WESP he could not perform any rotations, was unable to be independent in the water, and could barely perform a sipping action with mouth. After the WESP, he was able to perform a prone human stroke over 20 metres with relative ease and confidence. In group A the child who made least progress was participant 8, with HAAR total score changed from 31.25 to 56.25. Participant 8 was a 6-year-old boy with Asperger syndrome. He entered the program with no fear of the water and very limited water orientation skills. Eventually, he was able to float on his stomach

independently for 10 seconds and glide with bent leg kick with the instructor's assistance. In group B the child who made the most progress was participant 15; his HAAR total score changed from 43.75 to 81.25 during the post-WESP. This was a 7-year-old boy with Asperger syndrome. He could place his head in the water independently but with poor rhythmic breathing. After the WESP, he was able to perform a prone human stroke with straight leg kick independently and rudimentary arm movements with assistance. The child making least progress in group B was participant 16 who was diagnosed with Asperger syndrome. He began the program unable to perform movement in water independently and only able to perform three balance and controlled movements. At the end of 10 weeks' participation, he was able to glide on his stomach and recover to his feet with the instructor's help. From these descriptions, it is clear that the participants each developed a unique repertoire of aquatic skills.

The effect of the WESP on behavioral and social skills in the current study was evident in decreased antisocial behavior problems, but not in increased social competence behaviors. This is partially similar to Yilmaz et al.'s (2004) study which indicated that the duration of stereotypical autistic movements (spinning, rocking, and delayed echolalia) decreased for a total of 6 minutes over 45 minutes of swimming training. Many children with ASDs benefit from watching the positive social interactions of others. The WESP provides this during instruction in that most techniques are done in a small group at a one-to-two instructor-to-student ratio and repeated over and over. All strategies were implemented with the goal of making the social interaction mutually reinforcing to both the children with ASDs and their instructor and peers. Examples of strategies found in the class included facilitating sharing exchanges, encouraging children to seek assistance from each other, facilitating interactions during transitions and during group games and activities, addressing the proper etiquette, lining up for a turn, and even non-instructional socialization. Instructors and children perform the same techniques, and this provides opportunities for children and parents to participate together following identical routines.

Another possibility accounting for the reduction of anti-social behaviors found in the current study may be due to a favorable response to the individualized instruction and positive feedback provided by each instructor which could have increased motivation and enhanced perceived competence (Vallerand and Reid, 1984), with resultant gains in actual performance. In the WESP, the instructor had been patient and had ensured the participants treated each other with courtesy and respect. Each instructor had physically guided his/her two children through movement, taking time to explain and demonstrate things when the children did not understand. Eventually a close bond formed between the three. For example, participant 5 asked

his father to help him make a thank you note to his instructor at Christmas, and gave each child in the program candies to celebrate the holiday. Participants 1 and 3 liked playing around with their instructors and were occasionally invited to watch their instructor's soccer games. Halfway through the program the whole class of children were smiling.

Many other positive outcomes have been noted based on the open-ended questions provided to parents. Some parents reported significant improvements in their children's self-confidence and their social and athletic performances (participants 1, 2, 3, 5, 11, 12, and 15). Their children asked to participate in mainstream activities that they had previously avoided or been excluded from, and have in many cases expressed a desire to expand their swimming skills and social circles. In addition, parents were able to use class time to socialize and share notes on their parenting experiences. A sort of spontaneous support group and network were formed. Parents all reported the program has made a dramatic impact on their children's lives. They reported an increased sense of accomplishment and self-worth.

The limitations of this study should be recognized. First, the low sample size, small age range and single gender of participants (all male) limit generalization. Future research is warranted to establish the applicability of the current findings to individuals of both genders and at different stages of the life cycle through replication studies. Second, even though an attempt was made to obtain an equal size and type of ASDs in two groups of children with ASDs, differences in cognitive abilities and gross motor skills were not evaluated and might have influenced findings. Further research is needed to understand the impact of these variables on health-promoting physical activities in this population.

In conclusion, a 10 week WESP with an embedded social behavior component improves aquatic skills and holds potential for social skill improvements. The persistence of effects 10 weeks following WESP suggests a positive response to the treatment. Results from this study indicate that the environment provided by WESP enables individuals to develop physical skills within this intervention process and possibly enhances their behavioral and social skills in the future.

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