An Investigation on the Effectiveness of "Dolphin Encounter for Special Children" (DESC) Program for Children with Autism Spectrum Disorders

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Abstract

Children with autism spectrum disorders (ASD) share the common triad of impairments in social interaction, communication, and imagination or display of stereotyped behaviors. In this study, five subjects diagnosed with ASD, aged between 6 and 13 years-old, participated in the "Dolphin Encounter for Special Children" (DESC) Program offered by the Underwater World, Singapore, and was conducted at the Dolphin Lagoon in Sentosa, an island south of the mainland Singapore, for a period of 6 months. A pre- and post-treatment experimental design as well as qualitative case records was used to find out how the program had benefited the subjects and to what extent it had helped reduce their autistic traits/symptoms.

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According to Cochrane and Callen (1992), the use of animals for the purpose of providing therapeutic benefits to humans has been reported and published in several research studies (e.g., Iikura et al., 2001; Lukina, 1999; Nathanson, 1998), especially "in maintaining the equilibrium of the human mind and body" (p.31). Children with disabilities have been found to be positively impacted when they interact with animals such as cats, dogs, horses, or dolphins. In the findings of one study, Law and Scott (1995) reported that children with autism spectrum disorder (ASD) and pervasive developmental disorder (PDD) have benefited from pet care program using animals like hamsters, gerbils, guinea pigs, rabbits, and fishes in the following areas: (1) their anxiety or fear

level associated with animal contact decreased significantly; (2) responsibility through pet-care routines, such as feeding, cleaning and caring for the pet, was inculcated; and (3) problem-solving skills related to pet-care activities were developed over time. In addition, Law and Scott (1995) also highlighted the improvements in their subjects' self-confidence, social interaction, receptive and expressive language skills, and problem-solving skills.

Levinson (1969) termed this form of intervention as *pet therapy* or *pet-assisted therapy* which he argued is founded on two principal premises: (1) It is easier for an individual to project his/her unacceptable emotions on a pet; and (2) "the pet's faculty for supplying some of the individual's need for cuddling, companionship and unconditional acceptance" (Levinson, 1969:67). Such form of therapy may incorporate goals that are therapeutic in nature or emphasis on the development of relevant skills needed for the care of specific animals.

In this study, the authors have chosen dolphins (i.e., indo-pacific humpback dolphins, to be more specific) as the main animate instruments of treatment to work with five children diagnosed with autism spectrum disorders (ASD). Wing (1996) described ASD as triad of impairments: impaired social interaction, verbal communication problems and a lack of imaginative play or display of stereotyped behaviors. The term is used synonymously with pervasive developmental disorder (PDD). The classic form of ASD is often referred to as autistic disorder (Turnbull, Turnbull, & Wehmeyer, 2007). According to the Educator's Diagnostic Manual of Disabilities and Disorders (Pierangelo & Giuliani, 2007), autism is a spectrum disorder which includes the following: Asperger's syndrome, autistic disorder, childhood distintegrative disorder, high-functioning autism, hyperlexia, multiplex developmental disorder, Rett's syndrome, and other types of autism-be specific. While no specific underlying cause of ASD can be pinpointed, it is generally agreed and accepted that symptoms of autism are triggered by malfunctions to the brain (Szatmari et al., 1998). Treatments for children with ASD are many and varied, and they include both more conventional ones, such as speech language therapy, occupational therapy and educational therapy, and complementary/alternative or non-established, such as homeopathy and acupuncture.

Literature Review

As far back as in 1970s, dolphins have been the subjects of interests in research investigation relating to the understanding of effects of animal-human interaction on human behavior (Simpson, 2005). These marine animals have been trained to help individuals with disabilities with the aim to improve their cognitive, physical, or socio-emotional behaviors (Humphries, 2003). This form of approach to intervention became popularly known as dolphin-assisted therapy (DAT). Several experimental studies have been done to investigate the effectiveness of DAT with children with various disabilities (e.g., Lukina, 1999; Nathanson, 1998), other severe disabilities (e.g., Nathanson et al., 1997), mental retardation (e.g., Nathanson, 1989; Nathanson & de Faria, 1993), and autism (e.g., Servais, 1999; Smith, 1981).

Cochrane and Callen (1992) reported one study on how children with ASD were relieved of their characteristic anxiety (e.g., vocal and motor self-stimulations, and rocking movement) and stress through positive interactions with dolphins, and subsequently, these children also improved in their communication and learning. In another study using the single-subject case study method, Smith (1981) reported the use of dolphins to motivate a non-verbal child with ASD to communicate. Smith (2003) postulated that the intelligence and spontaneous play behavior of a dolphin could be its distinguishing features which help to enhance the therapeutic value of this particular marine animal.

In addition, studies done by Nathanson and de Faria (1993), Nanthanson et al. (1997), and Nathanson (1998) on the efficacy of dolphin-assisted therapy have suggested that this form of intervention helps to increase the attention of individuals with disabilities as well as ASD because of their desire to be in contact with the dolphins. Hence, according to these three studies, the human subjects showed an improvement in their cognitive performance, increase in motivation and self-confidence.

Although dolphin-assisted therapy has been the subject of several scientific investigations (see Marino & Lilienfeld, 1998), there is a lack of scientific or empirical validation regarding its efficacy (Exkorn, 2003). However, anecdotal reports and informal feedbacks from parents and professionals suggest that dolphin-assisted therapy has been very beneficial for some children with ASD (Simpson, 2005).

Description of Dolphin-Assisted Therapy (DAT)

There are many different forms of dolphin therapies. The simplest form can involve a child swimming with, touching or taking care of dolphins, while the more complex one, known as dolphin-assisted therapy (or DAT for short), is based on a structured program designed to meet the needs of the child concerned. According to Nathanson (1998), the DAT is based on the theory that children with disabilities will increase their attention to relevant stimuli in the environment as a result of their desire to interact with dolphins. The general purpose of DAT is to encourage children with disabilities to engage in desired responses in accordance with their individual education or therapy plan (Nathanson, 1998; Nathanson et al., 1997; Nathanson & de Faria, 1993).

The DAT consists of a series of therapeutic sessions during which the participants may interact with the dolphins from the pontoon or in the water after giving a correct motor, cognitive, or language response. Interaction with the dolphins may include touching, kissing, making hand signals to the dolphins to elicit specific behaviors, taking a short ride atop the dolphin while holding its dorsal fin, or dancing in a circular motion with the dolphin (Humphries, 2003). The DAT sessions are specially designed to "jump-start" the participating children with disabilities and to complement or reinforce other conventional therapies (Nathanson, 1998). The duration and frequency of the DAT varies from one providing organization to another, and it can be done in a few hours to several weeks or even months.

According to Humphries (2003), the materials used as adjuncts in the DAT include rubber balls or rings for eliciting motor responses, or big water-proof flash cards depicting objects for language responses.

Therapeutic Benefits of DAT

Several theories have been put forward to explain the purported therapeutic benefits of dolphin-assisted therapy, specifically the physiological and relational effects (Simpson, 2005). One prominent theory proposed by McKinney, Dustin, and Wolff (2001) has attempted to explain that dolphins could cause therapeutic physiological changes through their specialized use of sonar and echolocation. According to McKinney et al. (2001), this theory suggests that the whistles and clicks emitted by the dolphins can produce changes in an individual's tissue and cell structure, and works in some way similar to music therapy. In addition, because of their natural spontaneity, happiness, and playfulness, dolphins have a profound positive impact on individuals, and it is said to elicit happiness in individuals (McKinney et al., 2001). Moreover, dolphins are said to be particularly perceptive to the needs of individuals with disabilities, and as a result, they respond to such individuals in a very supportive manner (McKinney et al., 2001; Simpson, 2005). Finally, Dobbs (2000) suggested that dolphin-assisted therapy is effective in a mystical rather than medical way due to the unconditional love and caring advanced by the dolphin.

The "Dolphin Encounter for Special Children" (DESC) Program

While the DAT for children with special needs is not something new in the west, it is a novel form of intervention for children with disabilities in Singapore. Here, the parents of children with special needs are more than willing to try anything new that they hope will benefit their children. The Underwater World which manages the Dolphin Lagoon in the island of Sentosa –south of the mainland Singapore – offers its unique "Dolphin Encounter for Special Children" (DESC) Program that allows children with special needs to interact with its indo-pacific humpback dolphins (also known as pink dolphins).

As the dolphin therapy is a wholly unaccredited and unregulated industry, i.e., there are no regulations or operational standards to decide which form of dolphin therapy is the "true" or "real" professional one (Brakes & Williamson, 2007). Hence, the DESC Program, which has been offered to children with ASD, Down syndrome and physical disability since 2004, can be recognized as a unique form of dolphin therapy in this part of the world. According to Watanabe and Lee (2004), the main aim of the DESC Program is threefold: (1) to educate children with special needs on pink dolphins and their habits; (2) to provide these children a chance to interact with these marine creatures; and (3) to boost the self-confidence of these children when they physically encounter the pink dolphins in the lagoon.

The Study

Aim

The aim of this study was to find out whether the "Dolphin Encounter for Special Children" (DESC) Program would be an effective treatment in reducing the autistic symptoms of children with ASD. In this study, the term *autistic symptoms* refers to the traits pertaining to stereotyped or self-stimulatory behaviors, impairment in social interaction, and verbal communication problems.

Design and Data Collection

This study used a small group-based pre-/post-treatment design which is considered most suitable to determine the efficacy of the treatment such as the DESC Program. Because the design requires an introduction and completion of treatment, the functional relationship between the DESC Program as a treatment and child's autistic symptoms/traits could be established and studied (Tawney & Gast, 1984).

In brief, three steps were taken when employing this design:

1. Baseline data were taken (before undergoing a six-month treatment was instituted) on three types of autistic symptoms/traits (i.e., stereotyped behaviors, communication, and social interaction) observed, recorded and measured as well as the autism quotient of each subject being taken.
2. The treatment involved a six-month "Dolphin Encounter for Special Children" (DESC) Program.
3. Baseline data were re-taken (after completing the six-month treatment) on the same types of autistic symptoms/traits observed, recorded and measured as well as the autism quotients being re-measured.

In addition, qualitative data on the subjects' behaviors in terms of stereotyped behaviors, communication and social interaction were collected from their parents through emails, SMS, face-to-face conversations, telephone interviews, and letters. These qualitative case records allowed the authors to monitor each subject's progress in order to attend to every detailed response of the participants. While qualitative case records have been heavily criticized (see Esiner & Peshkin, 1990), Yin (2003) and Patton (2002) have argued the value and validity of the approach, especially in researching relatively new areas of study (see Marshall & Rossmann, 1999).

Participating Subjects

Initially, there were six subjects but the parents of one subject, who was diagnosed with Rett's syndrome, decided not to continue toward the end of the study. The remaining five subjects – two boys and three girls – had been officially diagnosed by the clinical psychologists from either the Child Guidance Clinic at the Institute of Mental Health, Singapore, or the Child Development Unit at Kandang Kerbau Women's and Children's Hospital, Singapore, to have ASD between the age of three and five years old. Among the five children, one boy (i.e., subject S2/M) was attending a regular primary school, one

girl (i.e., subject S4/F) was home-schooled by her parents, and the remaining three others attended special schools during the time when this study was conducted. Table 1 shows the gender and chronological age of each of the five participating subjects in this study.

Table 1
Subjects' Chronological Ages

Subject (N = 5)	Gender	Chronological Age
S1	Male	12 years 9 months
S2	Male	9 years 3 months
S3	Female	9 years 1 month
S4	Female	6 years 8 months
S5	Female	6 years 7 months

Key: N = Number of participating subjects; S = Subject

Instrumentation

Two standardized assessment tools were administered: (1) the Test of Non-Verbal Intelligence-Third Edition (TONI-3) (Brown, Sherberson, & Johnsen, 1982); and (2) the Gilliam Autism Rating Scale (GARS) (Gilliam, 1995).

Test of Non-verbal Intelligence–Third Edition (TONI-3)

The Test of Non-verbal Intelligence–Third Edition (TONI-3) (Brown, Sherberson, & Johnsen, 1982) – a highly standardized, psychometrically sound, norm-referenced intelligence test – is non-verbal, language free test that does not require any reading, writing, speaking or listening. It measures an examinee's ability of abstract or figural problem solving, for anyone ranging in ages from 6 years 0 months through 89 years 11 months.

TONI-3 was administered by the second and the third authors under the first author's supervision at the beginning of the study to determine the subjects' nonverbal intelligence quotients (NVIQs) in order to find out if any of the five subjects had mental retardation, which is often associated with ASD (Exkorn, 2003; Siegel, 1996). The results of TONI-3 (see Table 2) showed that since the NVIQs of the subjects except S2 (with an average NVIQ of 103) were between 70 and 79, i.e., within the intellectually low-functioning range, and therefore, strictly speaking, they did not qualify as having mental retardation (Brown, Sherberson, & Johnsen, 1982; Exkorn, 2003; Siegel, 1996).

Table 2
Subjects' Non-Verbal Intelligence Quotients (NVIQs)

Subject (N = 5)	Gender	NVIQ (TONI-3)
S1	Male	71
S2	Male	103
S3	Female	76
S4	Female	74
S5	Female	77

Key: N = Number of participating subjects; S = Subject

According to Brown, Sherberson and Johnsen (1982), the reliability of the TONI-3 (Form A) using Cronbach's coefficient alpha (Cronbach, 1951) for subjects between 6 years to 14 years is in the range between .89 to .93, and a standard error of measurement (SEM) ranging from .85 to 2.02. In addition, the reliability coefficients of TONI-3 (Form A) are as follows: content reliability is .93; time sampling is .91; scorer difference is .99; and an average reliability coefficient of .96. Thus, the test has a high degree of reliability.

Gilliam Autism Rating Scale (GARS)

Gilliam Autism Rating Scale (GARS) (Gilliam, 1995) was administered by the second and fourth authors under the first author's supervision and in consultation with the subjects' parents, at different times before the start of the DESC Program and it was re-administered at the end of the study – a week after the program had ended. The purpose of administering this assessment on the five subjects was to obtain their Autism Quotients (AQs), standard scores and percentile ranks based on the first three main subtests (Stereotyped Behaviors, Communication, and Social Interaction), excluding the fourth subtest on Developmental Disturbances, at pre- and post-treatment phases. With the results obtained at pre- and post-treatment phases, a comparative study could be made to determine if the subjects had benefited from the DESC Program (see Table 3).

Table 3
GARS Subtest Scaled Scores and Autism Quotients (Pre-Treatment Phase)

Subjects/Gender (N = 5)	GARS Subtests						Autism Quotients (SEM = 3)	
	Subtest 1: Stereotyped Behaviors (SEM = 1)		Subtest 2: Communication (SEM = 1)		Subtest 3: Social Interaction (SEM = 1)			
	SS	%ile	SS	%ile	SS	%ile	AQ	%ile
S1/M	13	84	12	75	10	50	112	79
S2/M	12	75	9	37	8	25	98	45
S3/F	14	91	12	75	11	63	115	84
S4/F	11	63	10	50	10	50	103	58
S5/F	12	75	10	50	9	37	102	55

Key: M = Male; F = Female; SS = Standard Score; %ile = Percentile rank; AQ = Autism Quotient; SEM = Standard Error of Measurement (as provided by Gilliam, 1995)

GARS is a highly standardized, non-referenced behavioral checklist, is used to identify persons ages 3 through 22 who are autistic. It consists of 42 items, which are categorized under three subtests: (1) Stereotyped Behaviors; (2) Communication; and (3) Social Interaction. There is a fourth subtest – Developmental Disturbances – consisting of additional 14 items about child development during the first three years, but it was not used in this study.

The reliabilities and validity of GARS have been provided by Gilliam (1995) as follows:

- Internal consistency reliability using Cronbach's coefficient alpha (Cronbach, 1951) is .96 with a standard error of measurement (SEM) at 3.0;
- Test-retest reliability coefficient is .88 with $p<.01$ as test of significance;
- Inter-rater reliability coefficients are .94 (teacher to teacher), .83 (parent to teacher), and .99 (teacher to parent) respectively;
- Median coefficients in term of content reliability are as follow: stereotyped behaviors .61; communication .65; social interaction .69; and Developmental Disturbances .61; and
- Median coefficients for each subtest were all statistically significant ($p<.01$).

Treatment

The "Dolphin Encounter for Special Children" (DESC) Program was conducted by the third author and one/two of her assistants only on Wednesday morning between 9.30am and 10.45am for a period of six months which began on August 13, 2008, and ended on February 18, 2009.

The program was divided into two parts: (1) classroom session; and (2) water session. For more details, see Watanabe and Lee (2004).

Classroom sessions:
The classroom sessions consisted of the following activities that were repeatedly taught and revised over again each time the subjects came for the program:

1. The subjects were introduced to a toy dolphin, which is close to a life-size one, for them to touch.
2. They were taught how to stroke the toy dolphin.
3. They were introduced to the different body parts of a dolphin through some hands-on activities or games.
4. They played with the Environment Cards to learn about the habitat of dolphins.
5. The subjects were also given opportunities to play with marine animal shapes and manipulatives.
6. They were taught to differentiate the dolphin from other marine animals using marine animal shapes and manipulatives.
7. They were also taught how to differentiate a dolphin from a fish.
8. The subjects were also shown video tapes how a dolphin swims.

The materials used during each classroom session included the following:

- A huge vanguard with Velcro labels were used to teach body parts of a dolphin.
- A dolphin float or soft toy dolphin was used to demonstrate how the subjects should touch the dolphin and everyone was given an opportunity to practice stroking the dolphin float or soft toy dolphin before actual water experience could commence.
- Plastic dolphins and fish were used to show how a dolphin (up-and-down motion) and a fish (side-to-side motion) swim differently.
- 3-D wooden or foam marine animal shaped puzzles and manipulatives were used to teach the subjects how to differentiate or recognize dolphins from other marine animals.
- Environment cards (e.g., ocean, forest, sky) were used to teach the different environments and the natural habitat where the dolphins live.
- Worksheets and coloring pencils were provided for individual participation of the subjects to observe how much they had learnt and understood what was taught during the classroom session.
- Certificates and colorful stickers were given to the subjects as a form of incentive to reinforce their classroom learning.

Water sessions:
The water sessions consisted of the following activities that were repeatedly taught and revised over again each time the subjects came for the program:

1. The subjects were introduced to three dolphins and learnt the christened name of each dolphin (i.e., Jumbo, Han, and Euang).
2. They were taught to adopt an interaction position, i.e., standing at waist level in the Dolphin Lagoon, to stroke a real dolphin and to count the number of strokes. They were given an opportunity to feed the dolphin.
3. They were gradually introduced to a higher water level, i.e., above waist level, in the Dolphin Lagoon.

4. They were taught to adopt a new interaction position, i.e., knee down position, to stoke a dolphin and to count the number of strokes.
5. The subjects were taught to make some hand signals to cue the dolphins to perform some tasks in response.
6. The subjects were led to walk up the pontoon in the Dolphin Lagoon by the third author and her assistants to do some hand signals to interact with the dolphins.
7. They would go into the Dolphin Lagoon and stayed in the water at different water level from shallow knee level to chest level depth to touch and stroke the dolphins.
8. The subjects would be supervised by the third author and/or her assistants to perform dorsal tow or deep-water contact and interaction with the dolphins.

The materials used during each water session included the following:

- Instead of putting on life jackets, arm floats were used by the subjects when they went into the Dolphin Lagoon as they provided better control and promote better attention during the water session. Also, some of the subjects had challenging sensory issues and resisted putting on his/her life jacket.
- Other adjunct materials (e.g., rubber balls and rings) that might be used as and when needed.
- At the end of each session, the third author and/or her assistants would recapitulate the lesson taught in that morning and rewarded the subjects with stickers for every small achievement made (e.g., responding appropriately to a request made, such as how to stroke a dolphin).

Dolphins

In most DAT studies, the bottle-nose dolphins are used. However, the dolphins used in this study are the indo-pacific humpback dolphins (an endangered species in captivity) kept and taken care in the Dolphin Lagoon which is managed by the Underwater World, Singapore. They are also commonly known as pink dolphins because of the pastel pink sheen of their skin. These dolphins start off life grey and then become pink as they mature. These dolphins were brought in to Singapore from Thailand in November 1999 (Boo, 2001). They are thought to be a unique sub-species of the Chinese white dolphin, also a member of the indo-pacific humpback dolphin family. These dolphins can be found in small populations off the coast of China, Singapore, Thailand and Vietnam.

Potential Risks of Treatment

According to Simpson (2005), while there are no known dangers associated with this form of treatment using dolphins, ethical issues regarding the humane use of dolphins for therapeutic purposes have contributed to this treatment status as a controversial intervention. However, guidelines have been developed to look into the welfare of dolphins used in this form of treatment: e.g., decrease in contact time between dolphins and human subjects, use only dolphins born and bred in captivity, and use of natural lagoon settings (Nathanson, 1998).

Results and Discussion

As mentioned earlier, the authors wanted to find out whether the "Dolphin Encounter for Special Children" (DESC) Program would be an effective treatment to help reduce the following autistic symptoms/traits of children with ASD: stereotyped or self-stimulatory behaviors, impairment in social interaction, and verbal communication problems.

As Simpson (2005) has recommended, the "evaluation of treatment efficacy related to dolphin-assisted therapy should emphasize measurement of social interaction, communication, motivation, and associated outcomes" (p.40). Hence, for this first reason, the authors have chosen to administer the GARS to evaluate the DESC Program based on its three main component subtests, i.e., Stereotyped Behaviors, Communication, and Social Interaction, respectively.

Children with ASD are impaired in their developmental behaviors, i.e., social, cognitive and communicative (Quill, 1995). Cognitive behavior reflects how an individual goes about solving problems or achieving tasks that require thinking (Frith, 1988; Leslie & Frith, 1988). "This unique ability in problem solving seems related to the basic inability of children with ASD to think abstractly" (Quill, 1995:76). When social behavior is added to the cognitive behavior to form what is known as social cognition, the concern is on how one (1) knows what to do in social situations, (2) infers the intentions of others, (3) empathizes with others, (4) interprets social cues, and (5) sees another's point of view (Fullerton, 1996). However, it is beyond the scope of this study to deal with this social-cognitive behavioral aspect. The social behaviors, which include self-stimulatory or stereotyped behaviors, and communicative behaviors, which include both verbal (i.e., speech) and non-verbal (e.g., hand gestures and facial expressions), are the main focus in this study.

When social and communicative behaviors are put together, they form what Quill (1995) termed as social communication, which is defined as "a reciprocal, dynamic relationship based on mutual understanding, enjoyment, and benefit" (p.164) and that a child's active involvement in naturalistic contexts helps promote social-communicative interactions. In simple terms, the subtleties of these interactions involve the use and coordination of non-verbal with verbal forms of communication and the understanding of social situations (Fullerton, 1996). Children with ASD manifest social communication impairments which are, in turn, related to cognitive differences. In other words, impairments in social-communicative interactions are intertwined with cognitive differences. "The development of social-communicative interactions involves a complex interplay of abilities in cognitive, language and social domains; the relationships across the various domains are so apparent that any effort to provide intervention in one area must consider all the other systems" (Quill, 1995:164). For this reason, GARS was selected by the authors for administration because its three subtests cover the social-communicative interactional behaviors.

Results obtained in this study are examined under each of the three GARS subtests as well as the subjects' Autism Quotients (AQs), which are in turn based on the sum of the scaled scores obtained from the three subtests. In addition, the mean standard scores and standard deviations for all the three GARS subtests at pre-treatment and post-treatment phases are used in the discussion of the results (see Tables 4, 5, 6 and 7 and Figures 1, 2, 3 and 4). Median and mode are not used here for two obvious reasons: firstly, the median will not be a representative value since the sample size (N = 5 at both pre- and post-treatment phases) in this study is far too small; and second, there is more than one mode in the distribution. Also, while the standard error (SE) of the mean may usefully be computed to provide an indication of the size of the uncertainty, it is not used here, as already mentioned, the sample size is too small (Ong, 1980). Instead the authors have used the Standard Error of Measurement (SEM) – an indicator of the error variance associated with a specific test score – provided by Gilliam (1995) found in the GARS examiner's manual (see p.22-23).

GARS Autism Quotients

Table 4 shows that the pre-treatment AQs and the post-treatment AQs remained more or less the same. In other words, the probability of autism and its degree of severity for each of the five subjects remained consistent throughout the six-month program.

Table 4
GARS Autism Quotients and Probability of Autism: Pre- and Post-Treatment **Results**

Subjects/Gender (N = 5)	GARS Autism Quotients (SEM = 3)				Probability of Autism
	Pre-Treatment Autism Quotients		Post-Treatment Autism Quotients		
	AQ	%ile	AQ	%ile	
S1/M	112	79	111	77	Above Average
S2/M	98	45	97	42	Average
S3/F	115	84	113	81	Above Average
S4/F	103	58	102	55	Average
S5/F	102	55	102	55	Average
Mean AQ	106	65	105	63	Average
SD	7.18		6.75		

Key: AQ = Autism Quotient; %ile = Percentile rank; SD = Standard Deviation; SEM = Standard Error of Measurement (as provided by Gilliam, 1995)

According to Gilliam (1995), "if the subject's AQ is 90 or above, the person is probably autistic ... Autism Quotients of 90 through 110 are within the average range for subjects with autism in the normative sample. Approximately 50% of the subjects with autism scored in this range ... Autism Quotients equal to or greater than 111 are highly indicative of autism. The probability of non-autistic subjects receiving scores this high is very unlikely" (p.16-17).

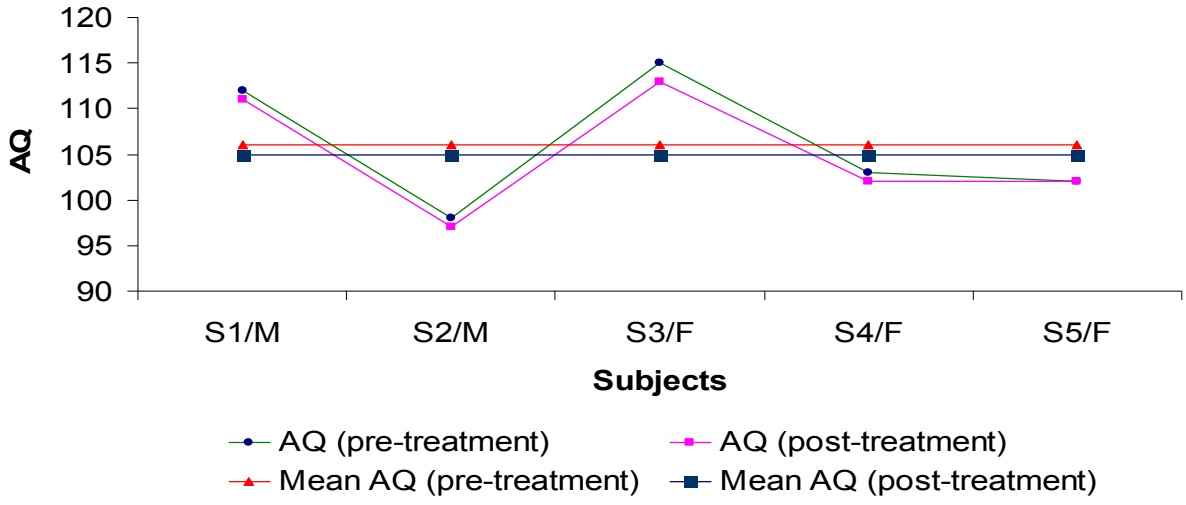
The mean AQ at pre-treatment phase was 106 (SD = 7.18) at 65%ile rank. The AQs of two subjects S1/M and S3/F were above the mean AQ, while the other three, S2/M, S4/F and S5/F, fell below it. The mean AQ at post-treatment phase was 105 (SD = 6.75) at 63%ile rank, which was not much different from the mean AQ at pre-treatment phase. The same two subjects had their respective AQs above the mean AQ and likewise, the same three subjects' AQs below it.

The findings of this study show that subjects S1/M and S3/F with AQs greater than 111 were highly or severely autistic. According to the parents of S3/F, when the family was in the United States two years ago, the child was diagnosed by a gastroenterologist to have autistic enterocolitis – a controversial term first used by Wakefield et al. (1998) to describe a form of regressive ASD resulting from gastro-intestinal disorder. All the other three subjects S2/M, S4/F and S5/F scored within the average AQ range of 90-110 in which 50% of the normative sample in the GARS study was found (see Gilliam, 1995). For the subject S2/M, he was previously observed, diagnosed and followed-up by a clinical psychologist and an educational therapist to possess a superior motoric systemizing ability in playing piano. Such a child is often identified as an autistic savant (see Chia, 2008).

Figure 1 provides a clear comparison of the five subjects in terms of their respective AQs before and after undergoing the DESC Program for six months. The graph shows the first mean AQ at pre-treatment phase and the second mean AQ at post-treatment phase. Clearly, the subjects S1/M and S3/F were severely autistic (high above the two mean AQs) while the other subjects S2/M, S4/F and S5/F were mildly to moderately autistic (below the two mean AQs). Although there was a slight decrease in the AQs for all the subjects except S5/F whose AQ remained the same for both pre- and post-treatment phases, the drop was insignificant. All the subjects remained autistic.

Figure 1

Comparison of GARS Autism Quotients: Pre- and Post-Treatment Results



During the study, informal parental feedbacks were also gathered by the first, second and fourth authors to find out how the parents of the participating subjects felt about the DESC Program. In fact, all the parents expressed their satisfaction with the program and would very much like to put their children through the program for a full one-year if ever there was one. However, they were unable to obtain permission and support from the respective schools, which their children are still attending, to attend a long-term DESC Program, as one parent put it, "The school principal is concerned that the dolphin therapy program would disrupt my daughter's studies and she might not be able to catch up with her peers."

GARS Subtests

As mentioned earlier, the GARS instrument consists of four subtests (Stereotyped Behaviors, Communication, Social Interaction, and Developmental Disturbances) of which only the first three were used in this study. According to Gilliam (1995), "standard scores of 8 through 12 ... are within the average range for subjects with autism in the normative sample. Approximately 50% of the subjects with autism scored in this range. Standard scores above 12 ... are highly indicative of autism. The probability of non-autistic subjects receiving scores this high is very unlikely" (p.16-17). In addition, the subtest standard scores of 6 or 7 are below average for subjects with autism and represent borderline scores in terms of the likelihood of autism. "Significantly low scores are standard scores below 6 on any subtest ... In the normative sample, less than 9% of the subjects with autism scored this low" (Gilliam 1995:17).

GARS Subtest 1: Stereotyped Behaviors

Table 5 shows that there was a significant decline in the stereotyped behaviors (e.g., hand flapping, tiptoeing when walking, and vocal self-stimulation) observed in all the five subjects. In fact, the parents reported to the first and the second authors an observable change in their children's behaviors in terms of reduced vocal and motor self-stimulations, hand flapping and rocking movements. The mean standard score for the GARS subtest on Stereotyped Behaviors for the five subjects at pre-treatment phase was 12.4 (SD = 1.14) estimated at 75%ile rank, and at post-treatment phase was 9.4 (SD = 1.14) estimated at 37%ile rank. There was a drop in the mean standard score by 3 standard points, and in terms of percentile rank, a significant drop from 75%ile to 37%ile rank was noted.

At the individual level, the standard scores for the GARS Subtest 1 of the two subjects S1/M and S3/F were above the mean of 12.4 at pre-treatment phase and 9.4 at post-treatment phase. At pre-treatment phase, the subject S1/M's standard score of 13 was 0.6 above the mean while the subject S3/F's standard score of 14 was 1.6 above the mean of 12.4. Both the subjects had standard scores within the above average range (13-14). At post-treatment phase, their standard scores remained consistently 0.6 and 1.6 above the new mean of 9.4, but this time, their standard scores fell within the average range (8-12). The lower the standard score, the better the prognosis, and vice versa. This means that the two subjects S1/M and S3/F showed improvement. Their standard scores at pre-treatment

phase dropped by 3 standard points respectively at the post-treatment phase. For the other three subjects S2/M, S4/F and S5/F, their standard scores (within the average range) fell below the means by 0.4 to 1.4 standard points at both pre-treatment and post-treatment phases respectively. The standard scores of all three subjects S2/M, S4/F and S5/F dropped by 4, 2 and 3 standard points respectively from pre-treatment to post-treatment phase. These interesting findings suggest that there was a significant reduction in self-stimulatory behavior or stereotypy observed among the five subjects.

Table 5
GARS Subtest 1: Stereotyped Behaviors
(Pre- and Post-Treatment Results)

Subjects/Gender (N = 5)	GARS Subtest 1: Stereotyped Behaviors (SEM = 1)					
	Pre-Treatment Results			Post-Treatment Results		
	RS	SS	%ile	RS	SS	%ile
S1/M	28	13	84	21	10	50
S2/M	26	12	75	13	8	25
S3/F	32	14	91	24	11	63
S4/F	23	11	63	17	9	37
S5/F	25	12	75	16	9	37
Mean Standard Scores		12.4	75		9.4	37
SD		1.14			1.14	1

Key: M = Male; F = Female; RS = Raw Score; SS = Standard Score; %ile = Percentile rank;
SD = Standard Deviation; SEM = Standard Error of Measurement (as provided by Gilliam, 1995)

Self-stimulating behaviors have always been a major challenging behavioral issue that both parents and professionals have to deal with when working with children with ASD. Commonly known as *stimming*, the behavior can involve gazing at a wall or fixating on an object for a very long time. It also includes repetitive body movements, such as rocking back and forth, snapping fingers near the ear, flapping hands continuously, as well as repeatedly moving objects, such as switching the light on and off.

According to Exkorn (2005), self-stimulatory behaviors can occur in different ways and involve any of the senses (see Appendix 1). The question why children with ASD engage in stimming is something that still baffles the experts. One explanation is that such behavior releases opiate-like substances called beta-endorphins in the brain and these in turn produce a euphoric effect. Another hypothesis proposed that stimming "provides an extra dose of internal stimulation for children with ASD who are feeling under-stimulated or a feeling of tranquility for those who are feeling over-stimulated" (Exkorn, 2005:48). According to Quill (1995), "there is a possibility that this (i.e., stereotyped behaviors such as rhythmic stereotypic rocking or flapping) may damage the developing nervous system by preventing or restricting the brain from receiving sensory input" (p.40).

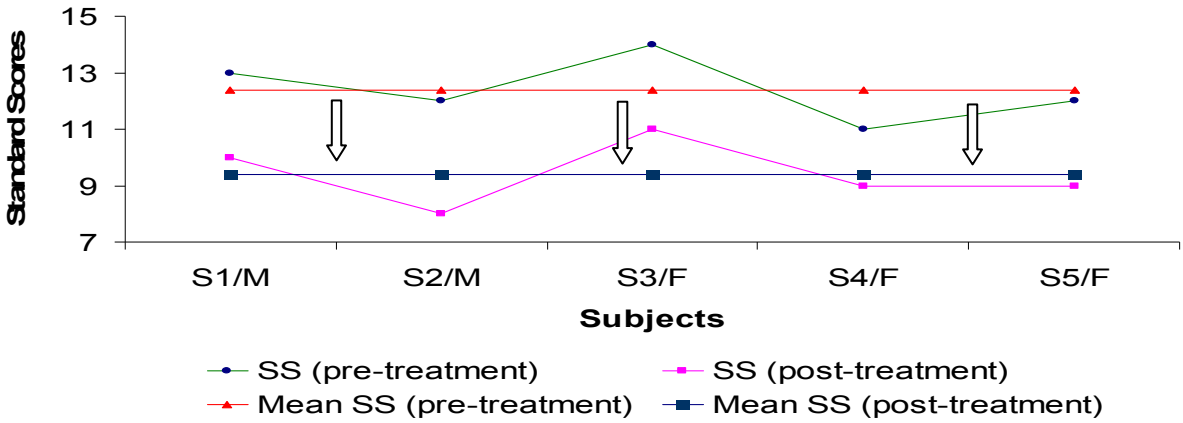
Experimental studies (e.g., Melzack & Burns, 1965; Simons & Land, 1987) done on animals suggest that certain areas of the brain become abnormal and hyperactive when sensory input is restricted.

Figure 2 shows an interesting comparison of results between pre- and post-treatment phases. Firstly, there was a significant drop in terms of the mean standard score for the GARS Subtest 1 on Stereotyped Behaviors from 12.4 at pre-treatment phase to 9.4 at post-treatment phase as indicated by the downward pointing arrows. Secondly, all the five subjects showed a reduction in their self-stimulatory behaviors as explained earlier. There was a drop of between 2 and 4 standard points down from the subjects' respective standard scores at pre-treatment to post-treatment phase for this subtest.

A plausible explanation given is that the clicks and whistles produced by dolphins help to reduce stereotyped behaviors (see McKinney, Dustin, and Wolff, 2001; Smith, 1981). According to a study done by Akiyama and Ohta (2007), dolphins produce either pulse sounds (e.g., clicks and burst pulse sounds) or non-pulse sounds (e.g., whistles) in their vocalization in situations where they interact with human, providing "an effective treatment for human health via interactions with dolphins. Vocal data obtained during contact with humans might serve as an important index that can be used to improve dolphin-human interactions, especially for the dolphin-assisted therapy" (p.169).

The present authors want to caution at this point that such an improvement (i.e., reduction in stereotypy of the subjects) does not mean that the DESC Program has been effective. It is inappropriate to attribute improvement solely to the program. It could be due to other therapies that the parents of the five subjects had sent them to, but did not inform the authors. Nevertheless, the positive results of this first subtest were quite impressive.

Figure 2
Comparison of GARS Subtest 1: Stereotyped Behaviors (Pre- and Post-Treatment Results)



Informal feedbacks from the parents were highly positive. What they had observed in their children back at home as well as the feedbacks they got from their children's teachers was very encouraging. All of them had told the first and fourth authors that the self-stimulatory behaviors were most disturbing and irritating to them especially when they brought their children outdoors. According to them, strangers who did not understand such behavioral issue often frowned on their children or even called them "retarded." The parents of S1/M and S3/F told the first author that their children either had stopped injuring themselves (through self-injurious activities such as head banging, eye-poking, or hand-biting) or there was a reduction in the self-injuring behaviors. While not all self-injurious behaviors should be considered to be self-stimulatory, they can also be communicative, especially for those who feel frustrated when they are unable to tell their parents what they want (Exkorn, 2005; Siegel, 1996).

GARS Subtest 2: Communication

Unlike the first GARS subtest, the post-treatment results of the second GARS subtest (see Table 6) fail to show any improvement in all the subjects' communication. The mean standard score for the GARS subtest on Communication for the five subjects at pre-treatment phase was 10.6 (SD = 1.34) estimated at 56%ile rank, and at post-treatment phase was 12.2 (SD = 1.3) estimated at 75%ile rank. There was an increase in the mean standard score by 1.6 standard points, and in terms of percentile rank, a significant rise from 57%ile to 75%ile rank being noted. A rise in the standard score and percentile rank suggests an increase in the severity of this autistic symptom/trait.

Table 6
GARS Subtest 2: Communication
(Pre- and Post-Treatment Results)

Subjects/Gender (N = 5)	GARS Subtest 2: Communication (SEM = 1)					
	Pre-Treatment Results			Post-Treatment Results		
	RS	SS	%ile	RS	SS	%ile
S1/M	28	12	75	34	14	91
S2/M	17	9	37	23	11	63
S3/F	27	12	75	30	13	84
S4/F	21	10	50	27	12	75
S5/F	20	10	50	24	11	63
Mean Standard Scores		10.6	57		12.2	75
SD		1.34			1.3	

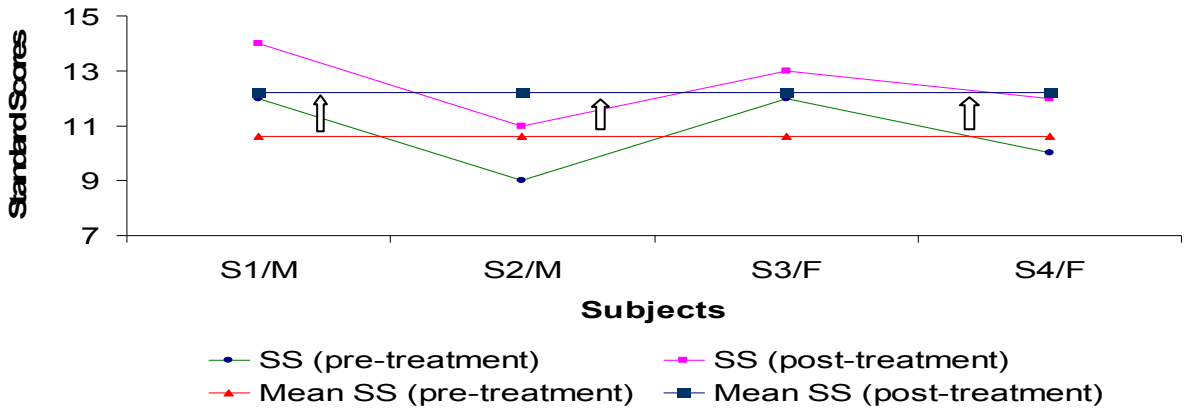
Key: M = Male; F = Female; RS = Raw Score; SS = Standard Score; %ile = Percentile rank;
SD = Standard Deviation; SEM = Standard Error of Measurement (as provided by Gilliam, 1995)

Like the results of the first subtest, a similar observation has been noted in this GARS Subtest 2 that the standard scores of subjects S1/M and S3/F were above both pre- and post-treatment means, while those of subjects S2/M, S4/F and S5/F were below the respective pre- and post-treatment means.

At the individual level, from pre-treatment to post-treatment phase, there was an increase between 1 and 2 standard points for the five subjects. At the pre-treatment phase, the standard scores of all the five subjects for this subtest fell in the average range (8-12). However, at the post-treatment phase, two subjects S1/M and S3/F had their standard scores raised to above average range (13-14). In other words, their verbal communication problems had become worse. It must not be forgotten that both subjects S1/M and S3/F with above average AQs were highly or severely autistic (see Table 4). The standard scores of the other three subjects S2/M, S4/F and S5/F for this subtest remained within the average range (8-12).

Figure 3 shows three upward pointing arrows indicating an increase in the severity of the verbal communication problem for all the five subjects in terms of their respective standard scores obtained in this subtest. As explained earlier and shown in Table 6, the mean standard score for this subtest went up from 10.6 at pre-treatment phase to 12.2 at post-treatment phase with an increase by 1.6 standard points. The higher is the standard score, the more severe is the problem, and vice versa. In this case, the standard scores for all the subjects went up and it means that communication to them had become a more challenging issue.

Figure 3:
Comparison of GARS Subtest 2: Communication
(Pre- and Post-Treatment Results)



Also mentioned earlier, self-injurious behaviors can also be of communicative nature, i.e., these children with ASD may hit their heads or bite themselves, for instance, because they are frustrated for being unable to tell their parents what they want or need. A decrease in stereotyped behaviors or stereotypy should result in a better overall score for this subtest on Communication, but it did not seem to be the case in this study. One

explanation could be that the degree of reduction in stereotypy or self-stimulating behavior reported earlier in the first subtest might not be sufficiently low enough to impact positively on their verbal communication. Another explanation is that *communication* is more than just mere *speaking* that the term seems to imply. Communication is a reciprocal interaction and it includes gestures and body language, too (Fullerton, 1996). Poor performance in this subtest suggests that the subjects were having difficulties in understanding context-dependent words, difficulties in understanding expressions, and difficulties in understanding humor (Fullerton, 1996). Although language delay is a common problem among children with ASD (Le Couteur et al., 1989) and this is also true of the five subjects, their language (grammar, vocabulary, and word understanding) of communication (or verbal communication, to be exact) may or may not be impaired. However, the way they use their language may be problematic. In addition, children with ASD may also have challenging issues with receptive language, which is associated with their capacity to understand. Although some of these children can understand at literal level, they do still have impaired listening and reading comprehension (especially at inferential, critical and/or appreciative levels) which results in them being hyperlexic.

Besides, communication can also be non-verbal. According to Siegel (1996), true non-verbal communication "involves a type of 'mind-reading' – knowing that what you're thinking is somehow going to be conveyed to someone else through your facial expressions or gestures, and without the use of words" (p.44). This is known as the theory of mind (ToM), which is the ability of an individual to recognize oneself and others as thinking beings, and the term refers to "the individual's ability to impute mental states to others" (Tan-Niam, 2003). Since children with ASD lack the ToM, this results in "unawareness of others' thoughts and feelings, and so contributes to the lack of interest on the part of autistic children in sharing their triumphs and failures with significant adults" (Siegel, 1996:45). Hence, when it comes to communication, a lack of ToM makes it hard for a child with ASD to know where to begin his/her experience – non-verbally or verbally. This best explains why the five subjects did not perform better in the second GARS subtest on communication.

Informal feedbacks from parents to the first and the fourth authors were less positive. Most of them expressed their concern when they told the first or fourth author that their children continued to repeat words, phrases and anything that might mean little or nothing to them. In other words, these subjects (except the subject S2/M) continued to display echolalia, as the term implies, is like echoing what they have heard or spoken to them, a symptom of hyperlexia (Chia, 2003).

These findings seem to suggest that DESC Program might not be an appropriate approach to treat verbal and/or non-verbal communication problems. Such challenging issues are best dealt with by using other conventional therapies such as speech language therapy, oral-sensory motor therapy and clinical play therapy.

GARS Subtest 3: Social Interaction

Like the second GARS subtest, the results of the third GARS subtest also fail to show any overall improvement in the five subjects' social interaction (i.e., recognition of social cues, understanding of others and social situations, reciprocity, friendship, and subgroups of social characteristics, which include being aloof, passive, active but odd, and/or overly formal and pedantic) (Wing & Gould, 1979). The mean standard score for the GARS subtest on Social Interaction for the five subjects at pre-treatment phase was 9.6 (SD = 1.14) estimated at slightly below 50%ile rank, and at post-treatment phase was 10.6 (SD = 1.14) estimated at 57%ile rank. There was an increase in the mean standard score by only 1 standard point, and in terms of percentile rank, a small increase from 50%ile to 57%ile rank.

Table 7
GARS Subtest 3: Social Interaction
(Pre- and Post-Treatment Results)

Subjects/Gender (N = 5)	GARS Subtest 3: Social Interaction (SEM = 1)					
	Pre-Treatment Results			Post-Treatment Results		
	RS	SS	%ile	RS	SS	%ile
S1/M	27	10	50	29	11	63
S2/M	21	8	25	22	9	37
S3/F	29	11	63	31	12	75
S4/F	26	10	50	26	10	50
S5/F	23	9	37	28	11	63
Mean Standard Scores		9.6	50		10.6	57
SD		1.14			1.14	

Key: M = Male; F = Female; RS = Raw Score; SS = Standard Score; %ile = Percentile rank;
SD = Standard Deviation; SEM = Standard Error of Measurement (as provided by Gilliam, 1995)

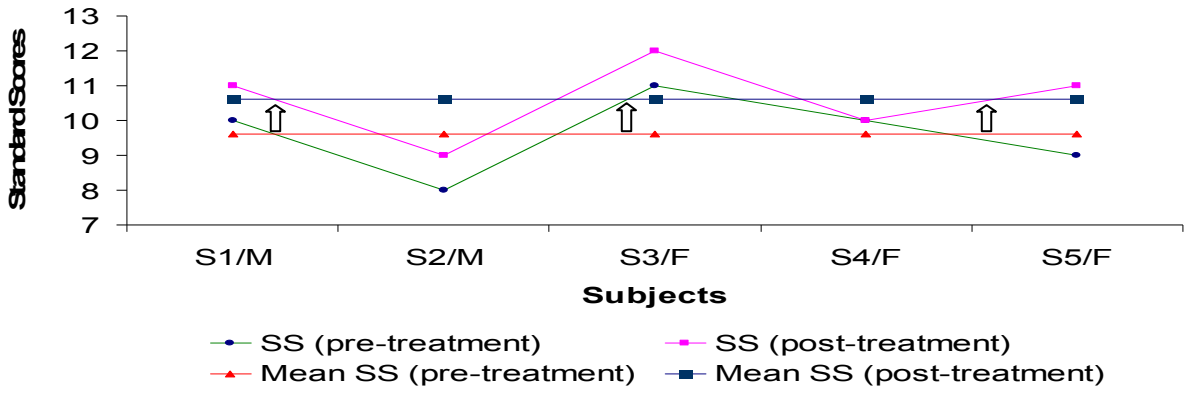
At the individual level, from pre-treatment to post-treatment phase, there was an increase between 1 and 2 standard points for all the subjects except S4/F whose standard scores remained the same. At both pre- and post-treatment phases, the standard scores of all the five subjects for this subtest fell within the average range (8-12). However, the standard scores of the two subjects S1/M and S3/F were above the mean standard score of 9.6 at pre-treatment phase and also above the mean standard score of 10.6 at post-treatment phase. The only subject, whose standard scores for this subtest that were below the respective means at pre- and post-treatment phases, was S2/M, an autistic savant.

An interesting observation was noted when S4/F's same standard score of 10 was above the mean of 9.6 at pre-treatment phase but fell below the mean of 10.6 at post-treatment phase. Another interesting observation was also made concerning the subject S5/F whose

standard score was below the mean at pre-treatment phase but went up above the mean at post-treatment phase. While the standard score of S4/F remained the same at 10 for both pre- and post-treatment phases, the standard score of S5/F went up from 9 at pre-treatment phase to 11 at post-treatment phase, an increase by 2 standard points.

Figure 4 shows an interesting comparison of the subjects' standard scores at pre- and post-treatment phases. Like the previous results seen in the second subtest, three upward pointing arrows indicating a slight increase in the degree of severity in the impaired social interaction for three subjects S1/M, S3/F and S5/F in terms of their respective standard scores obtained in this subtest. The subject S2/M showed the best results, both his standard scores were below the means. As for the subject S4/F, she did not actually improve, but by default, her same standard score of 10, which was above the mean at pre-treatment phase, now fell just below the second mean at post-treatment phase.

Figure 4
Comparison of GARS Subtest 3: Social Interaction
(Pre- and Post-Treatment Results)



It is not easy to interpret the pre- and post-treatment standard scores and percentile ranks of every subject when the focus is on the results of the third subtest alone. However, once these findings are placed within the context of social interaction and communication, it becomes clearer why the subjects failed to perform well in the second and third subtests. To understand what this means, it is important first to know what the purpose of social interaction and that of communication are, and then put them together to form what is known as social-communicative interaction (see Quill, 1995) which has already been described earlier.

According to Quill (1995), "the purpose of social interaction is pleasurable and active engagement with others, while the specific function or purpose of communication is to influence change and have an impact on others in some way. As such, communication is a social act, but not all social acts are communicative in nature" (p.166). When social interaction and communication are placed together, they form a reciprocal, dynamic relationship, and social-communicative interactions are promoted. Pre-verbal social

communication skills include joint attention, imitation and use of vocalizations as well as gestures to engage and regulate others' behaviors. At this stage of development, children are able to initiate or elicit social responsiveness through social contact, observation of others, and keeping a joint attention with another through vocal or object play. Turn-taking, imitation of simple actions, vocalizations all calls attention to oneself and regulates another person's behavior (Bates, 1976). Once language emerges, children develop a range of verbal and non-verbal means to communicate with one another in order "to satisfy basic needs, exert control over the environment, establish social relationships, request for information, share experiences, and express individuality through language" (Quill, 1995:166). At the same time, non-verbal features such as vocal quality, eye contact, and physical proximity are used flexibly to support social-communicative interaction.

However, children with ASD often fail to develop their pre-verbal social communication skills at the beginning of their social interaction and communication development, and as a result, they suffer social communication impairments throughout their development in this aspect. This explains why all the five subjects had failed to improve their standard scores in the two GARS subtests on communication and social interaction, which means poor social-communicative interactional performance.

Informal feedbacks from parents for this third subtest were rather mixed. Two parents said that they did not see any improvement in their children (i.e., S1/M and S3/F) while the other three claimed to have seen a drastic improvement in their children's social interaction with their friends. Parents of two younger subjects S4/F and S5/F told the first author that their children had reduced in their hand-leading (i.e., a child with ASD takes the hand of an adult and puts it directly on the thing he/she wants the hand to manipulate), and began finger-pointing at the things they wanted. According to Siegel (1996), hand-leading is "a very functional means of communication, but it is atypical of most children" (p.46) and it "develops after the autistic child can walk, and before the autistic child can point (if he ever does)" (Siegel, 1996:46).

It is also interesting to note that the parents of subjects S2/M, S4/F and S5/F, and to some extent, S1/M, told the first author that their children had attempted to use hand signals (taught by the third author to elicit specific behaviors from the dolphins) to engage their friends back in their schools or siblings at home. The first author felt that the hand-signaling these subjects had learnt to elicit dolphin responses during the DESC Program could be used as a springboard to teach them sign language for the purpose of communication and social interaction (or social-communicative interaction) as a follow-up intervention. In a study done by Tincani (2004), children with ASD who were taught sign language produced a higher percentage of vocalizations during training than those who were taught using the Picture Exchange Communication System (PECS) – an augmentative communication program designed for those who lack expressive language (Frost & Bondy, 1994).

The first and the second authors had also observed that some form of positive joint attention was established between the third author and each of the five subjects as they

took turns to interact (via hand signaling) with the dolphins during the water session. In other words, the hand signaling activity has promoted some form of joint attention between the third author and each of the subjects during the water session to engage the dolphins. The term *joint attention* can mean different things to different people and there is no one agreed definition of the term (Yoder & McDuffie, 2006). In this study, the authors refer joint attention to the resultant behavior when the third author actively manipulated (via hand signaling) to the animate object (dolphin) during the time the subject was engaged in on-looking. The dolphin was the shared object focus during this joint attention (i.e., hand signaling to the dolphin to elicit a response from it), but the subject might show little or no awareness of the social partner, i.e., the third author. The third author hand-led each subject to perform some hand signals to elicit appropriate responses from the dolphin. Diagram 1 illustrates the three-stage procedure of establishing a joint attention:

This form of engagement is known as *passive joint attention* (Bakeman & Adamson, 1984). It the same like when a mother manipulates or talks about an object during the time her baby is engaged in on-looking or object play. Although there is some shared object focus during the passive joint attention, the baby shows little awareness of its mother.

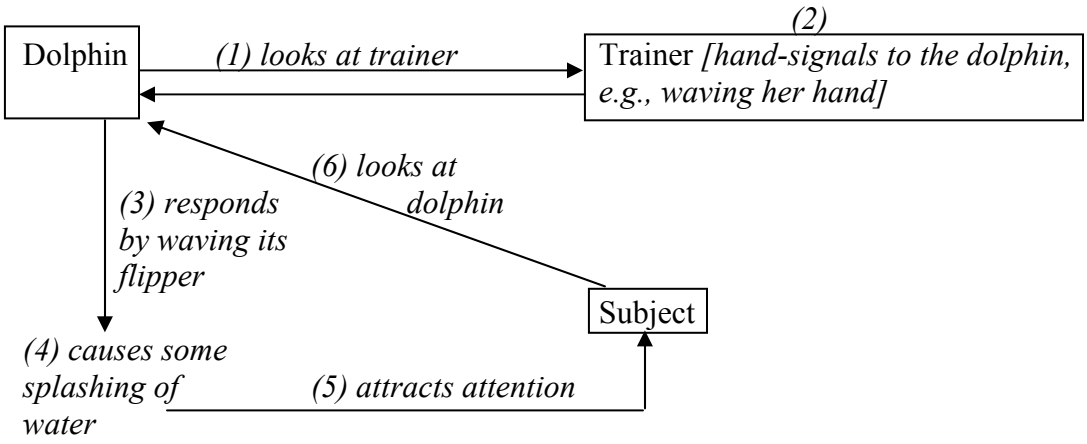
Summary of Pre- and Post-Treatment Results

To sum it all, the important findings of the study are as follows:

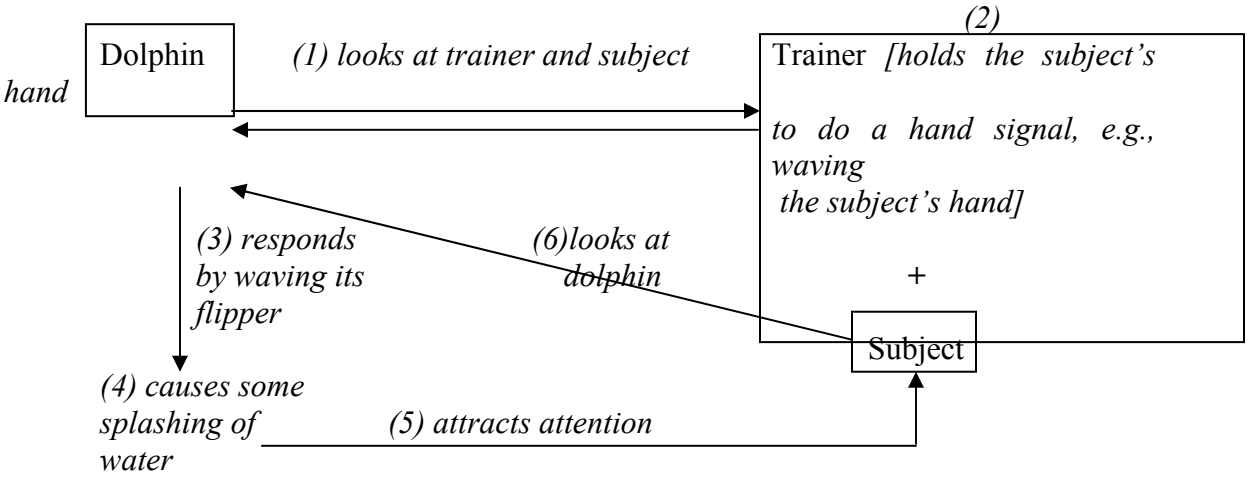
- The mean AQ dropped by 1 standard point from pre-treatment to post-treatment phase, which means it is 1 standard point less autistic than before, but the result is insignificant. The mean AQs at both pre- and post-treatment phases remained within the average range of severity of autism (90-110).
- There was a positive reduction in the mean standard score in the GARS subtest on the stereotyped behaviors by 3 standard points from pre-treatment to post-treatment phase, i.e., from slightly above average range of severity at pre-treatment phase down to the average range of severity at post-treatment phase.
- The mean standard score in the GARS subtest on communication went up by 1.6 from pre-treatment to post-treatment phase indicating that the communication problem had worsened, i.e., from average range of severity at pre-treatment phase up to slightly above average range of severity at post-treatment phase.
- The mean standard score in the GARS subtest on social interaction went up by 1 standard point from pre-treatment to post-treatment phase indicating that the degree of severity in impaired social interaction went up or worsened, but both means stayed within the average range of severity (8-12).
- The five subjects scored a better overall improvement in their reduced stereotyped behaviors than their overall improvement in social interaction, which, in turn, was better than that in their communication.

Diagram 1:
Establishing a Joint Attention through Hand Signaling to a Dolphin

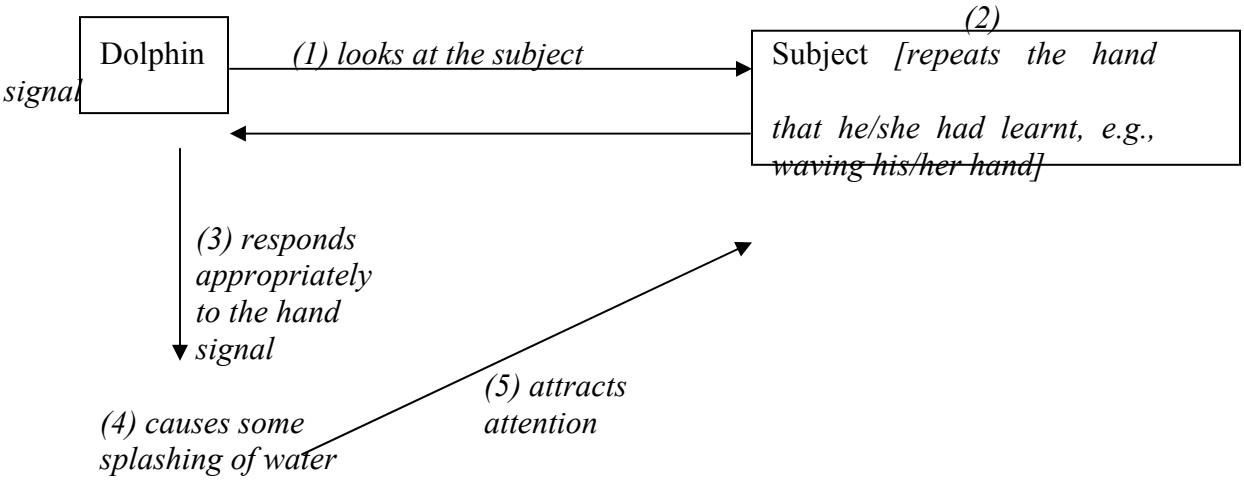
Stage 1:



Stage 2:



Stage 3: (could happen immediately after Stage 2 during the same water session or during another water session)



- There was a better passive joint attention in the subjects once they learnt to do hand-signaling to engage the dolphins. At the same time, a reduction in the subjects' hand-leading was also noted by the authors.

Table 8 shows the summary of as well as comparison between pre- and post-treatment results.

Table 8
Summary of Pre- and Post-Treatment GARS Results

GARS	Pre-Treatment Phase		Post-Treatment Phase		Difference between Pre- and Post-Treatment Means
	Mean	SD	Mean	SD	
Autism Quotients	**106**	**7.18**	**105**	**6.75**	**+1 (better)**
Stereotyped behaviors	**12.4**	**1.14**	**9.4**	**1.14**	**+3 (better)**
Communication	**10.6**	**1.34**	**12.2**	**1.3**	**−1.6 (worse)**
Social Interaction	**9.6**	**1.14**	**10.6**	**1.14**	**−1 (worse)**

Key: SD = Standard Deviation

Conclusion

Currently, there is very limited scientifically valid or reliable evidence to support the use of DAT for children with ASD as well as limited number of anecdotal reports about the use of DAT for these children (Marino & Lilienfeld, 2007). Based on the findings of this study, the authors felt that more could still be done to fine-tune on its focus, especially in the area of social-communicative interaction and the impact of DESC Program on it.

Limitations and Interferences

There are several limitations and interferences noted in this study. These are mentioned briefly below:

1. Autism is a spectrum disorder in terms of its various subtypes and degree of severity, and hence, it is difficult to get a sample of subjects whose ASD profiles are homogeneous. It is, therefore, not surprising if the DESC Program did not work well for everyone in this study since some of the subjects were more severely autistic than the others.
2. The authors acknowledged that it was difficult to control other factors (e.g., being in water, swimming in the lagoon, interacting with the dolphin trainers) of the treatment which might influence the results of this study.
3. Besides, the authors have also noted that it is difficult to stop parents from sending their children to other complementary and/or alternative therapies (without informing the authors as they were not obliged to do so) while they were still undergoing the 6-month DESC Program. Hence, it became difficult to conclude if the DESC Program

was the treatment that had helped or failed to help these subjects, and not because of the other therapies that they had undergone, too.

4. The novelty of the treatment and the excitement (or anxiety) on the part of the five subjects for their very first time to have a close physical encounter with dolphins might also influence the five subjects' behavior in this study. This is because these dolphins are distinct from the types of animals that these subjects are likely to encounter in their daily lives, such as dogs, cats and birds.
5. While the qualitative case record did provide more detailed information about each subject's progress, it could be a very subjective or biased parental viewpoint, since the parents of these subjects were quite aware of the study's purpose and hence, were more likely to have an expectation of improvement than what the GARS data had suggested.
6. Finally, the informal feedbacks from parents on their children's progress could be some kind of placebo effect, i.e., a measurable, observable or felt improvement in behavior not attributable to the DESC Program that was administered.

Precautions

The findings of this study are rather inconclusive. Although the study showed an overall improvement in terms of reduction in the subjects' stereotyped behaviors (e.g., decreased vocal and motor self-stimulation and rocking motion) and that some form of passive joint attention was established when engaging the dolphins, the DESC Program did not reduce the degree of impairment in their communication and social interaction. The authors want to caution that the DESC Program serves best as a complement to other conventional therapies and should not be used as a sole treatment for children with ASD.

Recommendations

There are two recommendations to be made. In the first recommendation, the authors proposed that if the overall mean standard scores of the second and third GARS subtests (i.e., communication and social interaction, respectively) were put together at pre- and post-treatments to obtain the estimated overall mean standard scores for social-communicative interaction, the subjects' overall performance in this aspect was noted be better than that of the second GARS subtest on communication but slightly poorer than that of the third GARS subtest on social interaction (see Table 9). This finding suggests that it is better to tackle the issue of social communication impairment as a whole than separately as communication and social interaction since both are closely intertwined (Quill, 1995).

In the second recommendation, single-subject research designs may be especially appropriate for research involving children with ASD participating in the DESC Program. One reason is that only a limited population for a specific disorder such as ASD may be available for participation in the study. Another reason is that no two subjects are homogeneous in every aspect even if they have the same kind of disorder, and in the case of autism, there are so many subtypes within this spectrum disorder.

Table 9
Estimated Mean Standard Scores for Social-Communicative Interaction (Pre- and Post-Treatment Results)

Proposed Factor	Pre-Treatment (Estimated Mean Standard Score)	Post-Treatment (Estimated Mean Standard Score	Difference between Pre- and Post-Treatment Means
Social-Communicative Interaction	**10.1**	**11.4**	**1.3**
Compare the above results with those in GARS Subtests 2 and 3			
GARS Subtests	**Mean Standard Score**	**Mean Standard Score**	**Difference between Pre- and Post-Treatment Means**
Subtest 2: Communication	**10.6**	**12.2**	**1.6**
Subtest 3: Social Interaction	**9.6**	**10.6**	**1.0**

Finally, the authors felt that from this study, two further studies could be done: (1) to examine how the DESC Program could help promote better joint attention, especially on the development of two types of joint attention – responding to joint attention and initiating joint attention – in children with ASD; and (2) to explore how the hand-signaling learnt in the DESC Program could be used as a springboard to teach children with ASD to learn a sign language to communicate and socialize.

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Appendix 1:

Senses and Self-Stimulatory Behaviors (Exkorn, 2005:47)

Sense	Self-Stimulatory Behaviors
Auditory	Vocalizing in the form of humming, grunting, or high-pitched shrieking, tapping ears or objects; covering and uncovering ears, snapping fingers; repeating vocal sequences; imitating vocal sequences (echolalia); repeating portions of videos, books, or songs at inappropriate times.
Visual	Staring at lights or ceiling fans or gazing at nothing in particular; tracking eyes; peering out of the corners of eyes; flicking fingers in front of face; lining up objects; turning light switches on and off.
Tactile	Scratching or rubbing skin with hands or objects; opening and closing fists; tapping surfaces with fingers.
Vestibular	Rocking back and forth or side to side; spinning, jumping; pacing.
Taste	Sucking or licking body parts or objects.
Smell	Sniffing or smelling people or objects.