THE EFFECTS OF AN ADAPTED PHYSICAL ACTIVITY PROGRAM ON MOTOR PERFORMANCE AND BEHAVIOUR OF CHILDREN WITH AUTISM SPECTRUM DISORDER

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DECLARATION

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Leanne Ferguson March 2010

ABSTRACT

The effect of an adapted physical activity (APA) program on the motor performance of children with autism was studied. A multiple single case studies approach was implemented. Three children with autism spectrum disorder (ASD), aged between three and eight years old, were chosen for the study.

A baseline, pre- and post-test assessment evaluated the effect of a 20-week intervention program. Motor abilities were tested using the Movement Assessment Battery for Children, and selected items from the Brockport Physical Fitness Test were used to assess physical fitness. The intervention was administered three times per week and focused on the individual motor impairments of each child. The program termed “Mighty Muscles” was continuously developed according to the child’s specific goals and developments. Additionally, social play and overall behaviour assessments were also done. The Sherrill-University of Virginia Adapted Physical Education Social Play Behaviour Inventory assessed social play and a behavioural profile developed by the researcher assessed daily living activities and behaviours associated with autism. Due to the nature of autism, the results of each child were analysed, graphed and discussed individually.

For the three children, the APA program had a positive effect in improving the motor abilities, including improvements in ball skills, manual dexterity and balance. The APA program also improved the physical fitness of the three subjects including aerobic capacity, muscular strength and endurance and flexibility. Self-stimulatory behaviours and inappropriate behaviours (fidgeting, self-injury) decreased in all three subjects while rates of appropriate physical activity during free time increased, demonstrating the positive contribution the APA program had on behaviours associated with autism. Social play became more spontaneous and interactive for case study two and three.

From this study, it is concluded that an adapted physical activity program is an essential addition in the holistic treatment of autism. This study provides further research and insight into the components of a successful APA program.

OPSOMMING

‘n Ondersoek is gedoen om die effek van ‘n Aangepaste Bewegingsprogram op die motoriese vermoë van drie kinders wat met outisme ge-identifiseer is, na te gaan. Die ouderdomme van die deelnemers wissel tussen drie en agt jaar.

‘n Gevalle-studie navorsingsontwerp is gebruik en die effek van ‘n 20-weeklange intervensieprogram is bepaal deur die resultate van basislyn-, voor- en na-programtoetsing te vergelyk. Motoriese vermoë is nagegaan deur gebruik te maak van die *Movement Assessment Battery for Children*, en liggaamlike fiksheid deur die gebruik van die *Brockport Physical Fitness Test.* Bykomend is waarnemings gemaak omtrent die sosiale speeltendense en algemene gedragspatrone van elke kind. Die *Sherrill –University of Virginia Adapted Physical Education Social Play Behaviour Inventory* en ‘n selfontwerpte gedragsprofiel, om alledaagse aktiwiteite en geassosieerde outistiese gedrag waar te neem, is ook benut.

Die intervensiesessies is drie maal per week gedoen en het gefokus op die motoriese agterstande van elke individuele deelnemer. Soos mikpunte bereik is, is die inhoud van die *Mighty Muscles* program voortdurend aangepas.

As gevolg van die unieke aard van outisme, is die resultate van elke kind afsonderlik ontleed, word dit afsonderlik illustreer en bespreek.

Die spesifieke aangepaste bewegingsprogram het ‘n positiewe effek op die motoriese vermoëns van al drie deelnemers gehad. Verbetering in bal-, handvaardighede en balansvermoë was opvallend. Die aërobiese kapasiteit, spierkrag en spieruithouvermoë asook lenigheid, met ander woorde fiksheid van al drie het as gevolg van deelname aan die intervensieprogram, verbeter.

Selfstimulerende en onvanpaste gedrag het afgeneem terwyl deelname aan meer gepaste, spontane vryetydaktiwiteite, duidelik waargeneem is. Al bogenoemde resultate dui op die positiewe bydrae van ‘n aangepaste bewegingsprogram op die gedrag van kinders wat met outisme geïdentifiseer is.

Die positiewe resultate van hierdie studie dui daarop dat die insluiting van ‘n Aangepaste Bewegingsprogram in die holistiese (behandelings) benadering van kinders met outisme ‘n belangrike toevoeging kan wees. Met beperkte geleenthede tans vir hierdie kinders om aan sulke programme deel te neem moet verdere ontwikkeling van Aangepaste Bewegingsprogramme deur middel van verdere navorsing sterk oorweeg word.

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ACRONYMS

ABA- Applied Behavioural Analysis

APA- Adapted Physical Activity

AS- Asperger's Syndrome

ASD- Autism Spectrum Disorder

BPFT- Brockport Physical Fitness Test

CDD- Childhood Disintegrative Disorder

DLS- Daily living skills

DTT- Discrete Trial Training

M-ABC- Movement Assessment Battery for Children

PDD- Pervasive Developmental Disorder

PDD-NOS- Pervasive Developmental Disorder- Not Otherwise Specified

RS- Rett Syndrome

Sherrill-UVA-APE social play behaviour- Sherrill-University of Virginia Adapted Physical Education Social Play Behaviour Inventory

SPA- Success in Physical Activity

TEACCH- Treatment and Education of Autistic and Related Communications-Handicapped Children

TGMD- Test of Gross Motor Development

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CHAPTER ONE

INTRODUCTION AND PROBLEM

Autism is a difficult disorder to define and people with autism have been described as deaf, severely emotionally disturbed, socially immature, mentally retarded, aphasic or communication impaired (Davis, 1990). Autism is considered to be a developmental disorder. The etiologies are unknown and the behavioural symptoms are heterogeneous (Reid & Collier, 2002). In South Africa autism affects one in 86 children under the age of six years and is four times more prevalent in boys than in girls. Currently 104 children are on a waiting list for schools and ten children per week are being diagnosed with autism at the Red Cross Children's Hospital (Autism Western Cape, 2009).

Diagnostic criteria include deficits in communication, social interaction and stereotyped interests, activities and behaviours. The Autism Society of South Africa composed the following characteristics and criteria for the diagnosis of autism (see Table 1) (Davies, 2007).

Table 1 Criteria for diagnosis for autism

Characteristics	Specific Behaviour
Severe impairment in reciprocal social interaction (at least two of the following).	• Inability to interact with peers, • Lack of desire to interact with peers, • Lack of appreciation of social cues, and/or • Socially and emotionally inappropriate behaviour.
All absorbing narrow interests (at least one of the following).	• Exclusion of other activities, • Repetitive adherence, and/or • More rote than meaning.
Imposition of routines and interests (at least one of following).	• On self, in aspects of life, and/or • On others.

Speech and language problems (at least three of the following).	• Delayed development of speech, • Superficially, perfect expressive language, • Formal, pedantic language, • Odd prosody, peculiar voice characteristics, and/or • Impairment of comprehension, including misinterpretations of literal/implied meanings.
Non-verbal communication problems (at least one of the following).	• Limited use of gestures, • Clumsy/gauche body language, • Limited facial expression, and/or • Inappropriate expressions.

Poor postural control, an inability to process sensory stimuli, impaired imitation skills and a low level of attention and arousal are all characteristics of autism that are not included in the diagnostic criteria but are all clinically important (Murray-Slutsky & Paris, 2000). Recently, more research is being done on the motor development of children with autism spectrum disorder (ASD) and how the impairments in this domain influence the way children perform and interact with their environments. Motor learning provides the initial foundation on which social and cognitive learning experiences are developed (Byrne & Hills, 2007). A weak foundation or inability to physically perform successfully can result in a negative learning and social experience.

Intervention for autism is based on the perceived symptoms of the disorder and it can come in as many forms as the autism itself. Once receiving a diagnosis of autism from a paediatrician, paediatric neurologist, psychologist or child psychiatrist there are several types of therapy one can pursue. Parents approach therapies to assist in dealing with symptoms of autism because treating the unknown cause is impossible.

Pharmacological interventions provide a medicinal approach to the symptoms of autism while dietary interventions look at removing foods that stimulate adverse behaviours and symptoms. Behavioural intervention therapies, currently the

most popular, seek to adapt the child's behaviour, using techniques to increase desired responses and decrease undesirable behaviours. Behavioural therapists are able to improve communication, social interaction and stereotyped behaviours by utilizing operant conditioning based programs and discrete trial training. Speech therapists, audiologists, occupational therapists and physiotherapists all play an important role in providing specialized, individualized therapy for each child. With autism the principle of 'one-size-fits-all' does not exist. Improvement depends on the severity of the autism in the child as well as the stage at which the therapy is initiated.

With the increase of research investigating the delayed motor domain of children with ASD and the effect it has on the child's life (Baranek, 2002; Gidley Larson & Mostofsky, 2006; Ozonoff, Young, Goldring, Greiss-Hess, Herrera, Steele, Macari, Hepburn & Rogers, 2008; Pan, 2009; Provost, Lopez & Heimerl, 2007), therapists are searching for facilities that provide stimulation and treatment for this delay. There is ample research indicating the benefits of exercise for adults. Recently research has indicated that physical activity and exercise for children is essential and provides an ideal opportunity to learn and develop essential motor skills and abilities. With regards to children with ASD, physical activity presents a chance for these children to not only participate in a field that physically they were previously unsuccessful in, but also a chance to improve existing motor impairments. These improvements in turn positively affect movement performance, social interaction and the self-confidence of the child (Byrne & Hills, 2007).

Due to motor impairments, participation in physical activity with neurotypically developing children becomes extremely difficult and sometimes nearly impossible. Adapted physical activity (APA) programs allow individuals with special needs the opportunity to participate in physical activities. These APA programs are designed with the specific needs and requirements of the individual in mind and allow physical activity to become a safe, accessible form of therapy for children with ASD. There are many important components to these programs and one specifically developed will allow for the focus to remain on the goals set out for the specific individual.

Presently there are limited APA programs existing for children with ASD, therefore research needs to be conducted in order to determine if these programs do, in fact, improve motor fitness and motor skills. It is also important to analyse the effect that improvements in this motor domain will have on the child's behaviour and quality of life of the child. Research in APA programs provides additional education to assist with further design and implementation of possible future programs.

The Problem

Rationale for the study

There is very little conclusive evidence that an adapted physical activity (APA) program for children with ASD is effective in improving motor skills and developing motor fitness.

The principal purpose of the research is to establish the impact that participation in an individualized APA program would have on the motor performance of children who have autism, and to determine if a relationship exists between the motor domain of children with ASD and participation in the program. Primarily the research will look at the effects of the APA program on motor skills (exclusively ball skills, manual dexterity, balance) and physical fitness (endurance, muscle strength and flexibility).

A secondary function is to depict how participation in the program may influence behaviors commonly associated with autism, the child's performance in therapy targets and overall quality of life. Insight may also be gained on how to implement such programs and an objective of this research is to develop examples of effective practice and develop guidelines for individualizing APA programs to promote motor performance of children with ASD.

Recently, it has been determined that children with ASD experience a range of motor difficulties including low muscle tone, delays in development of gross and fine motor skills and abnormalities in motor control, motor imitation, motor planning, posture, coordination, and gait (Gidley Larson & Mostofsky, 2006;

Jasmin, Couture, McKinley, Reid, Fombonne & Gisel, 2009; Murray-Slutsky & Paris, 2000). These impairments result in poor performance in daily and social tasks that require these motor abilities and skills. A poor performance results in a poor experience for the child which in turn affects the mental, social and physical well-being of the child.

APA programs allow individuals with specific needs to participate in physical education and sport (Hutzler & Sherrill, 2007). Through these individualized programs which are designed with the specific physical/mental condition of the participant in mind, individuals are able to focus on their unique goals.

Research Questions

By participating in an individualized APA program, it is hoped that an improvement in the motor abilities and fitness of the three children with ASD would occur, and consequently more successful interactions between the child and the surrounding environment would be observed. Ideally these developments in the child's life will positively affect the child's behaviour, response to therapy and overall quality of life.

1. Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?
2. Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?
3. Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

Limitations of the study

The effect of an APA program on the motor domain and behavioural responses of a child with ASD was investigated. The social, communication and cognitive fields of a child with ASD were not examined.

The effect of an APA program was investigated on specific motor abilities namely balance, ball skills, manual dexterity; and physical fitness namely endurance, muscle strength and flexibility. The effects on other physical fitness components, for example agility, coordination and power as well as body composition were not investigated.

There is limited or no data on the reliability and validity of the testing instruments used when applied to children with ASD. Therefore the validity and reliability data from other populations cannot be used to support the application of the testing instruments on children with ASD.

Three participants were selected for the study, each with a diagnosis of autism. The APA program was applied to each child in separate and different environments over a period of six months. The diverse and unpredictable nature of children with ASD as well as the inconsistent characteristics of human beings were some of the uncontrollable variables that resulted in the limitations to the study. Other uncontrollable variables included environmental factors and changes in the participants' diets, routines and therapies.

CHAPTER TWO

REVIEW OF LITERATURE

Autism

Autism has been described as a neurodevelopmental disorder characterized by the onset of symptoms prior to the child's third birthday (Chawarska & Volkmar, 2005). The Autism Spectrum Institute at the Illinois State University (2009) states that:

> "(Classic) Autism is the second leading childhood developmental disorder. Individuals with autism have impairments in the areas of communication, behaviour, and socialization. In addition, many individuals also experience sensory processing and regulation issues".

Nowadays it is commonly recognized that autism is not an emotional disorder, but the behavioural expression of a polygenetic developmental neurobiological disorder, which predominantly involves the dysfunction of the central nervous system (Panerai, Zingale, Trubia, Finocchiaro, Zuccarello, Ferri & Elia, 2009).

The diagnostic criteria for this behaviourally based disorder are defined by impairments in communication, social interaction and repetitive, restricted interests, imaginative play and behaviour (American Psychiatric Association, 1994). Autism does not have racial, ethnic or social boundaries and no two individuals with autism share identical symptoms. It is a spectrum disorder and commonly referred to as autism spectrum disorder (ASD), where individual's experience wide variances, ranging from mildly affected to very severely influenced (Murray-Slutsky & Paris, 2000).

As knowledge increases about the heterogeneity of ASD many argue that the current International Classification of Mental and Behavioural Disorders (ICD-10, 2007) and Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, 1994) are not adequate for all children on the "spectrum". During the past two decades, the ASD knowledge base has experienced a tremendous evolution concerning clinical presentation, family history, etiology, genetic testing,

environmental influence, co-morbidities and natural history, including the resolution of symptoms and response to treatments. This increase in information has left many clinicians unsatisfied with the current taxonomic approach of ASD (Rosenburg, Daniels, Kiely Law, Law & Kaufmann, 2009).

Pervasive Developmental Disorders (PDD) share many core characteristics of autism and it is due to this that the National Institute of Mental Health (2004) has stated that ASD is another term for PDD. Within this broad category (see Figure 1) there are various types of autism including classic or severe autism also referred to as Kanner's Syndrome, Asperger's Syndrome (AS), childhood disintegrative disorder (CDD), Rett Syndrome (RS), and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS).

Asperger's Syndrome, similar to autism, has been described with diagnostic features encompassing impaired social interaction and the obsessional pursuit of repetitive or idiosyncratic interests (American Psychiatric Association, 1994). However, normal cognitive and language development highlights the difference between AS and ASD (Green, Baird, Barnett, Henderson, Huber & Henderson, 2002).

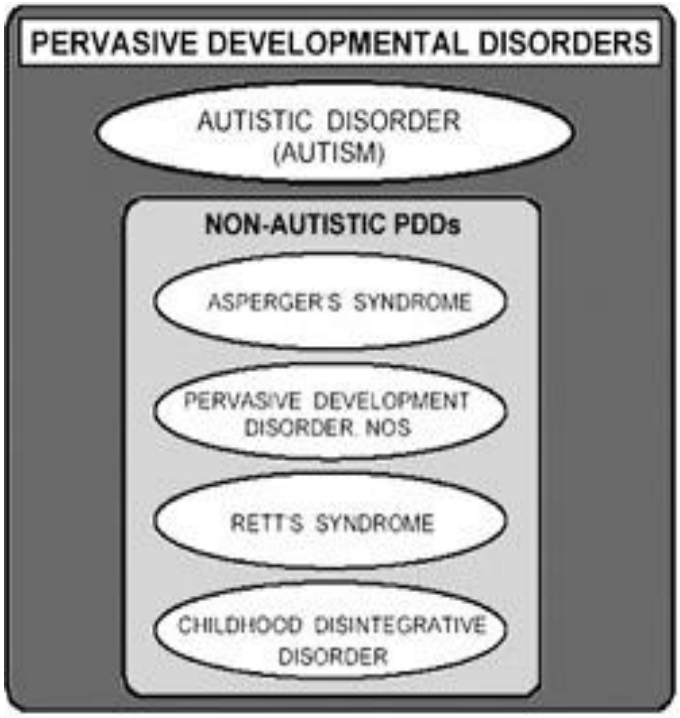

Figure 1 Types of Pervasive Developmental Disorders/ Autism (Siegel, 1996:158)

Differential diagnosis of CDD is determined largely by its pattern of onset (Palomo, Thompson, Colombi, Cook, Goldring, Young & Ozonoff, 2008). The child develops typically for the first two years, thereafter there is a loss of skills across multiple domains of development. These include language, social, cognitive, adaptive play, motor or self-help skills (American Psychiatric Association, 2000). Regression after a period of typical development does occur in autism, however the onset is earlier. After the commencement of regression and symptoms, CDD presents itself as autism and there is typically no further regression after developmental losses. Within this very rare PDD, there may be limited recovery of function (Palomo *et al.,* 2008).

Tsai (1992) recognises the phenotypic overlap that occurs between RS and ASD. However RS has through considerable amounts of clinic research been confirmed as a distinct neurodevelopmental condition. Cardinal features of RS include the neurodevelopmental course of regression and loss of hand skills, apraxia, deceleration of head growth, and increasing spasticity and scoliosis. The specific behavioural phenotype of RS currently forms part of the diagnostic criteria and behaviours include hand stereotypes, hyperventilation and breath holding (Mount, Charman, Hastings, Reilly & Cass, 2003).

Mesibov, Adams and Klinger (1997) explain PDD-NOS was introduced to classify individuals showing problems and disabilities related to autism, but that fall short of the number of characteristics or range of impaired areas that is required for a definition of autism. Individuals receiving a diagnosis of PDD-NOS tend to be higher functioning with better language skills than what is demonstrated in the average child with autism. Once thought to be a rare group of disorders, PDD's are now estimated to occur in one in 150 children in the general population. Factors that contribute to this increasing number of incidences include expanding diagnostic criteria, entire life span evaluations, improved assessment methods, more experienced and trained professionals and better funding for research and screening (Matson & Daniene, 2009).

Similar to other neurodevelopmental disabilities, ASD is considered generally not "curable" and requires chronic management. Even though outcomes are variable and specific behavioural characteristics change over time, most

children with ASD, regardless of intellectual functioning, remain within the spectrum as adults and continue to experience problems with independent living, employment, social relationships and mental health (Myers & Plauche Johnson, 2007).

Characteristics of autism

The term ‘triad of impairments’ has been developed in order to describe the three diagnostic criteria for autism (Gillberg & Coleman, 2000). The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) states that for a diagnosis of autism the child must experience difficulties in each of these three criteria (American Psychiatric Association, 1994):

1. A qualitative impairment in social interaction in at least two of the following areas: use of non-verbal behaviours such as eye contact and body gesture, development of peer relationships, spontaneous seeking to share interests or achievements, social reciprocity.
2. A qualitative impairment in communication in at least one of the following areas: development of spoken language, the sustainability of a conversation when speech is present, appropriate use of language, spontaneous imaginative or imitative play appropriate to developmental level.
3. Restricted, repetitive and stereotypical patterns of behaviour, interests, and activities in one of the following areas: preoccupation in stereotypical patterns of interest with abnormal intensity and focus, adherence and inflexible adherence to specific routines and rituals, stereotypical and repetitive motor mannerisms such as hand-flapping, persistent preoccupation with objects.

Stone (2006:12) states that:

> “Children with ASD will exhibit the disorder with a different range, intensity and frequency of symptoms but will always include atypical development in three primary areas, social skills, language and communication skills and repetitive and restricted behaviour”.

The following examples are where a child with ASD may exhibit impairment in the above-mentioned areas (Stone, 2006:12-17):

1. Impaired social skills: A child with ASD may not
    - Smile in response to a praise,
    - Respond when his/her name is called,
    - Initiate social interaction,
    - Show enjoyment in interactive or turn-taking games,
    - Imitate actions of adults, such as waving good-bye,
    - Join other children in play, or
    - Show an interest in making friends.

2. Impaired language and communication skills: A child with ASD may not
    - Make eye contact with other people,
    - Express his/her needs or desires to other people in conventional ways, such as reaching or vocalizing,
    - Use non-verbal gestures, such as such as nodding or shaking the head,
    - Look at other people's faces to seek information, or
    - Engage in back and forth babble "conversations.

3. Restricted interests and repetitive activities: A child with ASD may
    - Engage in repetitive play activities, such as lining up toys or spinning objects,
    - Act out repetitive movements, such as running in circles or flicking fingers,
    - Show prolonged visual interests in objects, such as flapping objects in front of their eyes, staring at mirrors or objects that spin,
    - Have overly focused interest in one object or activity, such as a fascination with cars or balls, or
    - Demand rigid adherence to routine and rituals.

A child with ASD might not play with a variety of toys or use toys in the way they are designed to be used. Toys might not be arranged in their intended scheme

and there might be no functional play with dolls, stuffed toys or toy figures shown, such as feeding a doll with a bottle. A child with ASD might not play with toys in a variety of ways (Stone, 2006).

Stone (2006:10) provides a comprehensive overview of the different disorders of autism and their characteristics (see Table 2).

Table 2 Characteristics of Autistic Spectrum Disorders (Stone, 2006)

Characteristics	Autistic Disorder	Asperger's Syndrome	Rett Syndrome	CDD	PDD-NOS
Social impairment	X	X	X	Xb	X
Language and communication Disorder	X		X	Xb	Xa
Repetitive interests and activities	X	X		Xb	Xa
Average intelligence		X			
Onset prior to 36 months	X		X		
Period of normal development followed by loss of skills			X	X	
Relative impairment	Variable	Milder	More severe	More severe	Milder
Relative prevalence	Higher	Intermediate	Lower	Lower	Higher

Note: a. At least one of these two features must be present
b. At least two of these three features must be present

Early indicators of autism include a child who does not babble, point or make meaningful gestures by the age of one. A child who does not speak one word

by 16 months or combine two words by 24 months is also considered to exhibit early indicators of ASD. Similar early indicators include no response to the child's name, a loss of language or social skills, avoidant eye contact, inappropriate play with toys or an obsessive attachment to one particular toy or object, and a child that does not smile or appears hearing impaired at times (Exhorn, 2005).

A child with ASD, however, can experience developmental delays in other areas outside of this triad. These are then termed associated symptoms that do not fall within this diagnostic constellation, but nonetheless appear to be neurologically and clinically important aspects of this disorder. A child with autism may exhibit motor skills, fitness levels, participation behaviours and intellectual functions that are below the expected range for a given age (Zhang & Griffin, 2007).

Individuals with ASD have been shown to have difficulties with processing and modulation of sensory input (Leekam, Nieto, Libby, Wing & Gould, 2007). These difficulties result in atypical responses to sensory stimuli, generally reported as hypo- and hyper-responsive reactions (Baranek, David, Poe, Stone & Watson, 2006). Murray-Slutsky and Paris (2000) noted how children would engage in sensory-seeking behaviours that are non-productive and have no organizing benefits. These self-stimulating behaviours were reported as disorganizing and interfering with the child's functional abilities. These motor mannerisms include hand-flapping, finger flicking, body rocking, facial grimacing, deep-head pressure and repetitive manipulation of objects and sequences, such as twirling and spinning (Mink & Mandelbaum, 2006; Richler, Bishop, Kleinke & Lord, 2007). These mannerisms fall within the triad of impairment and are highlighted as potential 'red flags' in autism in current clinical practice parameters (Loh, Soman, Brian, Bryson, Roberts, Szatmari, Smith, & Zwaigenbaum, 2007).

In both higher and lower functioning groups, studies have shown that imitation is specifically impaired in autism (Rogers, Cook & Meryl, 2005) There are several hypothesized mechanisms to account for this impairment, including symbolic content, visual representation, cross-modal transfer and working memory. These have been examined and rejected, while the mechanism with

the greatest support is motor planning/execution. However, this mechanism accounts for some, but not all of the variance in imitation performance.

Postural control has been defined as the control of the head, neck and trunk and includes motor control issues related to the pelvis and scapulae (Murray-Slutsky & Paris, 2000). In relation to autism, only a few studies focusing on postural control have been completed. Minshew, Sung, Jones, and Furman (2004) completed a study evaluating postural stability in 79 non-mentally retarded individuals with autism, between the ages five and 52 years old. (There was also a control group of 61 healthy neurotypical individuals.) Results of this study demonstrated a reduced postural stability in the autistic subjects. The study also showed that the reduction in stability is directly related to autism and not to mental retardation. With the autistic subjects, it was found that postural control did not begin to improve until the age of 12 and it did not reach adult levels. The cause of this postural instability has been identified as a possible motor dysfunction, as histopathological studies have revealed abnormalities in the cerebellum (Kohen-Raz, Volkmar & Cohen, 1992).

Indicators of poor postural control include a delay in or an absence of balance and equilibrium reactions, an inability to maintain postures resulting in slouching and fidgeting, and a particular standing posture. This can be identified by forward-tipped shoulders, anterior pelvic tilt with a potbelly appearance and hyperextension of the knees (Murray-Slutsky & Paris, 2000).

Other clinically important, associated symptoms in children with ASD include less than optimal levels of attention and arousal (Murray-Slutsky & Paris, 2000). This results in affecting their learning and performance levels. These children store and learn information very differently, therefore cognitively their functioning is different. Their limited repertoire of coping skills results in the development of undesirable and non-productive behaviours.

Causes of autism

Although there is presently more research being done in the field of autism, the etiologies of this disorder still perplex researchers world-wide. This broad

spectrum disorder is now known to have many etiologies. Once considered a psychiatric disorder, medical practitioners now look at it from a medical perspective. Early authors, such as Bettelheim believed autism was caused by a threatening and unloving mother known as the 'refrigerator mother' (Frith & Hill, 2003). Subsequently this theory has been disregarded by more current researchers as a cause for this disorder.

Autism has now been established as one of the multidimensionally-defined disorders of brain development that affects complex human behaviours (Rapin & Tuchman, 2006). Possible etiologies of autism include genetics, serotonin activity, viral causes and anything that causes a change or damage (structurally/functionally) within the central nervous system (Murray-Slutsky & Paris, 2000).

Steyaert and De La Marche (2008) report that ASD is a disorder with mainly genetic causes and that a variety of genetic mechanisms may be involved, i.e. single gene disorders, copy number variations and polygenic mechanisms. Findings cited in this report suggest complex heritability of autism and the possibility of different genes and biological pathways contributing to different parts of the ASD phenotype. Errors in neuronal connectivity have been supported as the cause for ASD in sub-populations of subjects. Baron-Cohen and Bolton (2002) state that the rate of siblings developing autism is considerably higher than would be expected from chance alone and that this finding gives some proof that genetic factors are involved.

It has often been reported that anatomically the brain volume and head circumference of an individual with autism is larger than that of a neurotypically developing child, in particular the cerebral cortex and limbic system, while less brain development has been shown in areas such as the cerebellum (Mesibov *et al.,* 1997). Early brain overgrowth is most pronounced in the frontal lobes and underlying mechanism of ASD include deregulation of cell growth, apoptosis and/or white matter development in the first year(s) of life (Steyaert & De La Marche, 2008).

Anzalone and Murray (2002) have suggested that neurological differences found in children with ASD, in comparison with children without autism, lead to abnormal processing of the sensory information. These differences include abnormalities in the cell structure of the cerebellum and limbic system. Together with many other researchers, it has been suggested that sensory disturbances are the primary deficits underlying autism (Grandin & Scarianda, 1993).

Baron-Cohen and Bolton (2002:31), given the common pregnancy and birth problems of children with ASD, give the following risk factors that have been reported in association with autism (however they do not state that these are causes of autism but rather part of the problem):

- Mother's above the age of 35 at the time of the pregnancy,
- Birth order in which the first or fourth or later born children carry a slightly higher risk,
- Medication during pregnancy,
- Meconium (first stool of the infant) was present in the amniotic fluid during the labour,
- Bleeding between the fourth and eight month of pregnancy, and
- A "rhesus incompatibility" between the mother's and the child's blood group.

Buckley and Kartzinel (2008:2) have defined autism as a medical illness and not a psychiatric disorder. Genetic vulnerability in the face of environmental exposure results in autism as a series of interacting vicious cycles impacting among others methylation chemistry, immune function and gut function. These researchers have explained ASD as a "jamming up of clockwork gears that spin inside every cell of the body". Instead of normally functioning clockwork gears, vicious dysfunctional cycles begin disrupting children's health. In order to break these vicious cycles, medical intervention should normalize function in each area.

Infections that have been reported to be associated with ASD include Rubella (German measles), Cytomegalovirus (CMV), and Herpes encephalitis. Other

medical conditions that can damage the nervous system and therefore can be considered to be a cause of ASD include genetic conditions such as Fragile X syndrome, tuberous sclerosis, Phenylketonuria, Neurofibromatosis and other chromosomal conditions. Metabolic conditions include the abnormalities in purine synthesis and carbohydrate metabolism. Congenital anomaly syndromes which can be considered include Cornelia De Lange syndrome, Noonan syndrome, Coffin Siris syndrome, William's syndrome, Biedl-Bardet syndrome, Moebius' syndrome and Leber's amaurosis (Baron-Cohen & Bolton, 2002).

Baron-Cohen and Bolton (2002:33) document the model known as the "Final Common Pathway" (see Figure 2), which postulates that a combination of factors, such as genetics, viral infections, pregnancy/births and other problems cause brain damage to some extent. This then results in the development of ASD or mental retardation depending on where the damage in the brain occurs.

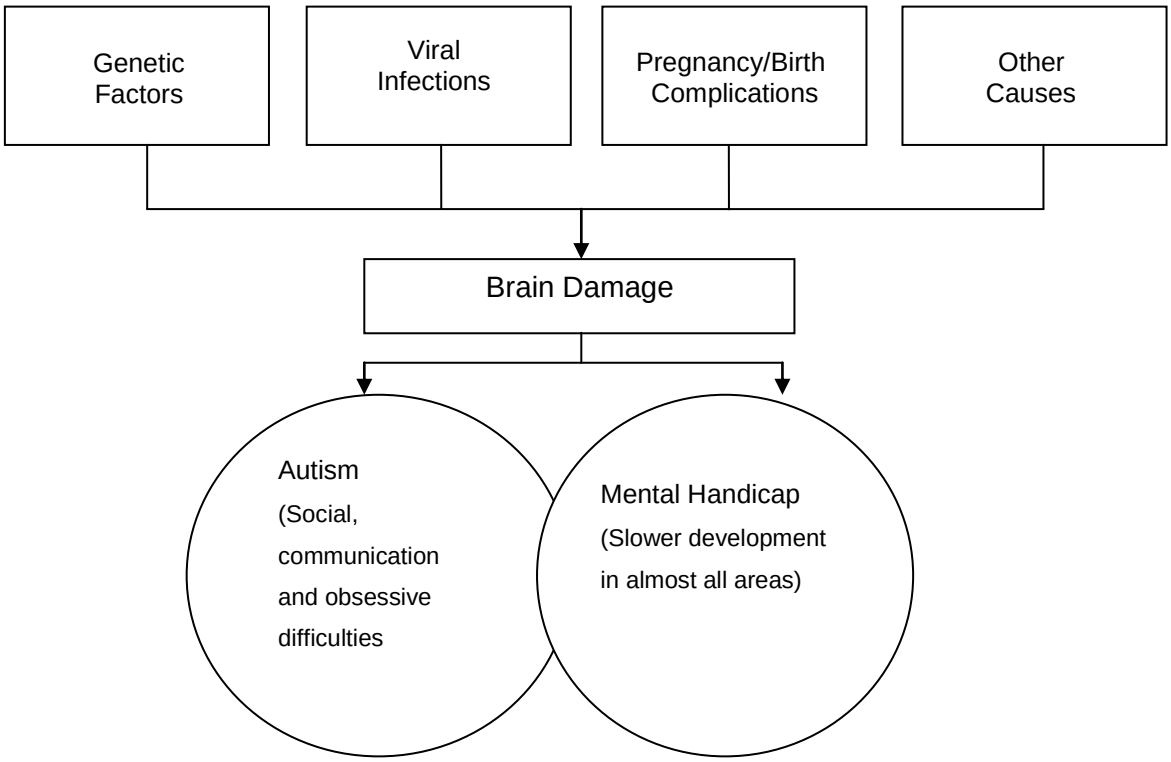

Figure 2 Final Common Pathway to autism

Interventions for autism

Primary goals for intervention and treatment are to minimize and alleviate the core features and associated deficits, maximize functional independence and quality of life and alleviate family distress. Myers and Plauche Johnson (2007:1162) state that “facilitating development and learning, promoting socialization, reducing maladaptive behaviours, and educating and supporting families” can all help accomplish these goals.

Autism is not only seen as a medical or biological dysfunction and the International Classification of Functioning, Disability and Health take into account the social aspects of the disability. Environmental factors are included in order to record the impact of the environment on the person’s functioning and dynamic interaction between the person with this disability and his/her “world”. As a result of this intervention strategies have been progressively oriented towards a psychoeducational approach in which the role of the parents has a great importance (Panerai *et al.,* 2009).

The cornerstones for management of ASD are adequately structured educational interventions, including behavioural strategies and habilitative therapies, which address communication, social skills, daily living skills, play and leisure skills, academic achievement, and maladaptive behaviours (Howlin, 1998; Myers & Plauche Johnson, 2007). One of the most popular methods to treating autism in the recent years has been behavioural based treatment methods. These techniques focused on the use of operant conditioning procedures to increase desired behaviours and reduce undesirable actions (Case-Smith & Miller, 1999). Examples of this therapy include Applied Behavioural Analysis (ABA) and Discrete Trial Training (DTT).

Applied Behavioural Analysis (ABA) is the process of applying interventions based on experimental psychological research to systematically change behaviour and to demonstrate that the interventions used are responsible for the observable improvement in behaviour. Research has shown that home-based early intensive behavioural intervention founded on the principles of ABA can produce dramatic improvements for children with ASD (Grindle, Kovshoff,

Hastings & Remington, 2009). DTT methods establish learning readiness by teaching foundational skills, including attention, compliance, imitation and discrimination learning (Myers & Plauche Johnson, 2007).

Structured teaching for children with ASD emphasises the improvement of skills as well as modifying the environment to accommodate existing deficits. Important elements of this intervention includes (Myers & Plauche Johnson, 2007):

- Organization of physical environments,
- Predictable sequence of activities,
- Visual schedules,
- Routines with flexibility,
- Structured work/activity systems and
- Visually structured activities.

An example of a structured teaching strategy for children with ASD is the Treatment and Education of Autistic and Related Communications-Handicapped Children program, commonly referred to as TEACCH, which modifies and restructures environments to accommodate the unique characteristics of students with autism (Schopler & Mesibov, 1994).

TEACCH takes into account the disorder's features and tries to minimize the child's difficulties using structured and continuous interventions, environmental adaptations and alternative-augmentative communication. The guiding-concepts of the TEACCH system have been summarized as improved adaptation, parents collaboration, assessment for individualized treatment, structured teaching, skills enhancement, cognitive and behavioural therapy and generalist training. In order to modify the environment to meet the child's needs the four main components related to this process include (Panerai *et al.*, 2009:875):

1. Physical organization that refers to the layout or setup of the teaching area for both academic and functional teaching,

2. Visual schedules that show students what activities they will do and when,
3. Work systems that inform students about what and how much activities have to be done, and
4. Task organization that informs students on within-task actions.

This study by Panerai *et al.* (2009) confirms TEACCH as an effective program for children with ASD as positive outcomes were produced in a natural setting. This study also showed that in order to increase the abilities of children with ASD and to decrease their maladaptive behaviours, their inclusion in a regular class is not sufficient and mainstream schools need to adopt structured teaching and flexibility with the aim of creating the appropriate conditions for an optimal development of children with ASD.

According to Myers and Plauche Johnson (2007) relationship-focused interventions include Greenspan and Wieder's developmental, individual–difference, relationship-based (DIR) model, Gutstein and Sheely's relationship developmental intervention (RDI) and responsive-teaching (RT) curriculum developed by Mahoney and McDonald. While DIR looks at '"floor-time" play sessions to facilitate emotional and cognitive growth and development, RDI focuses on activities that elicit interactive behaviours in order to develop positive social relationships and a motivation to learn skills to sustain these relationships. RT strategies encourage children to acquire and make use of pivotal developmental behaviours such as attention, persistence, interest, initiation, cooperation, joint attention and affect (Myers & Plauche Johnson, 2007).

Delays in speech and communication can be addressed with the help of speech and language therapists, while occupational therapists promote development of self-care skills and academic skills such as cutting and writing. Sensory integration (SI) therapy remediates deficits in neurological processing and the integration of sensory information to allow the child to interact with the environment in a more adaptive fashion (Myers & Plauche Johnson, 2007).

Autism is a life-long disorder although symptoms can change over the individual's life span. These changes are dependent on early detection, intervention and severity of the disorder (Gillberg & Coleman, 2000). Over the past two decades educational intervention has been focused on younger children as there is evidence that earlier identification and early intensive intervention may result in substantially better outcomes with a significant impact on behavioural problems and abilities (Bristol, Cohen, Costello, Denckla, Eckberg, Kallen, Kraemer, Lord, Maurer, McIllvane, Minshew, Sigman & Spence, 1996; Myers & Plauche Johnson, 2007; Panerai *et al.*, 2009).

Detecting early signs of ASD is essential for timely diagnosis and initiation of effective interventions. In addition to improving outcomes earlier diagnosis allows parents the opportunity to receive counselling regarding current estimates of recurrence risk in autism which they may take into consideration in future family planning (Zwaigenbaum, Thurm, Stone, Baranek, Bryson, Iverson, Kau, Klin, Lord, Landa, Rogers & Sigman, 2007).

Pharmacological therapies and medications are best considered ancillary treatments and not remedies or cures. Their advantages must be considered in light of their potential undesirable side-effects and toxicities (Mintz, Alessandri & Curatolo, 2006). Significant improvements to the core symptoms of ASD through psychopharmacotherapy have not been proved (Findling, 2005). However, drug treatments can be utilized in reducing symptoms, improving quality of life and making the child more amenable to non-pharmacological treatments (Malone, Gratz, Delaney & Hyman, 2005). The following drug treatments have been used as an intervention for children or adolescence with autism (Malone, *et al.,* 2005; Steyaert & De La Marche, 2008):

- Haloperidol (antipsychotic) is one of the most studied agents in autism and has been found to be effective in reducing hyper-activity, aggression, self-injurious behaviours, temper tantrums, lability of mood, irritability, social withdrawal and stereotypical behaviours.
- Risperidone (antipsychotic) has been demonstrated to be beneficial for irritability, repetitive behaviours and aggression but no significant effect on social-communicative features. This drug has been researched

extensively and proved to be significantly superior to the placebo, however adverse effects included weight gain, increased appetite, fatigue, drowsiness, dizziness and drooling.

- Olanzapine and Ziprasidone are other antipsychotics used to reduce similar behaviours but research-based evidence for their effectiveness is lacking.
- Selective serotonin reuptake inhibitors (SSRIs) are used for depressive disorders and compulsory behaviours in patients with ASD, however their use in children has much been debated as children may be at a higher risk for behavioural activation and disinhibition.

Certain treatment interventions are usually directly related to the perceived cause of the disorder of the individual. For example, the physiological based cause of autism called the “opioid-excess” theory states that maladaptive behaviours by physiological imbalances are caused by incomplete breakdown and absorption of peptides found in food containing gluten and casein (Savery, Shattock, Rodgers & Whitely, 1999). Therefore, dietary intervention would be used in this case, and foods containing gluten and casein would be removed from the diet.

In South Africa, there are institutes and schools that provide a variety of approaches to assisting and teaching children with ASD. These include the following: Alpha, Vera, Growth Through Knowledge, Vista Nova, REACH, SNAP and The Centre for Play and Learning. Parents, with the help of a knowledgeable and experienced professional, can develop a comprehensive and effective therapy plan for their child. This can be done once a thorough assessment of the child’s cognitive abilities, social-communication skills and aberrant behaviours has been completed. Successful treatment approaches are multimodal and interdisciplinary, using the expertise of paediatric neurology and psychiatry, developmental paediatrics, neuropsychology, behavioural psychology, speech and language, physical and occupational therapies and education. It is critical that therapeutic and education interventions are individualized and tailored to the child’s specific needs (Mintz *et al.*, 2006).

Motor deficits in autism

Leo Kanner is considered to be one of the pioneers in autism (Lyons & Fitzgerald, 2007) and was the first to identify “early childhood autism” as a distinct clinical entity (Williams, Costall & Reddy, 1999). In 1943, Kanner described children with ASD exhibiting stereotyped behaviours and clumsiness in both gait and gross motor performance (Rapin & Tuchman, 2006). Since these early accounts evidence has accumulated to indicate that impairments in motor development are consistent and common across both low and high functioning individuals.

Differences in motor development are not considered as a primary diagnostic category for ASD (Provost *et al.*, 2007). However, over the past few decades there has been an increasing interest in the importance of motor functioning of children with ASD and a growing recognition that individuals with autism experience motor difficulties (Berkeley, Zittel, Pitney & Nichols, 2001; Jasmin *et al.,* 2009; Morin & Reid, 1985; Ozonoff *et al.,* 2008). These include “abnormalities in basic aspects of motor control, including gait, posture, coordination and tone, as well as difficulties with imitation and with pantomime of complex gestures” (Gidley Larson & Mostofsky, 2006:68). Motor impairments in children with ASD lead to difficulty negotiating their physical environments, fine motor control, including tying shoes or writing, and social play including riding a bike or throwing a ball (Jansiewicz, Goldberg, Newschaffer, Denckla, Landa & Mostofsky, 2006).

Many children with ASD demonstrate atypical motor features (including low muscle tone, repetitive motor movements and dyspraxia) and test in the delayed ranges on standardized motor assessments, especially as the complexity of the task increases (Baranek, 2002). Through retrospective video analysis, motor dysfunction has been identified during infancy suggesting that this dysfunction is a core deficit of autism (Baranek, 1999). Studies on both fine and gross motor skills in children with ASD are limited, however have demonstrated motor delays (Provost *et al.*, 2007), poor motor skills (Yilmaz, Yanardag, Birkan, & Bumin, 2004), difficulties with motor coordination (Gillberg

& Coleman, 2000), motor planning (Portwood, 1999) and postural control (Kohen-Raz *et al.*, 1992; Minshew *et al.,* 2004).

Gross motor testing of children with autism show these children have:

- Difficulty with low muscle tone,
- Hyperextensibility of joints,
- Standing postures characterized by lordosis and locked knees,
- Mushiness of muscles when palpated,
- Difficultly with understanding body scheme,
- Difficultly with coordination and timing of movements,
- Poor midrange joint control and
- Difficulty with grading of arm and leg movements.

Slow sustained postures that are difficult for the child to hold include prone extension, supine flexion, single-limb stance and Romberg position (the child stands either with feet together or heel-to-toe with eyes closed) (Murray-Slutsky & Paris, 2000).

It is common for children with ASD to attain developmental milestones, such as sitting, crawling, standing and walking. However, these children have underlying hypotonia or low muscle tone (Rogers *et al.,* 2005), resulting in the quality of their performance in these milestones to be poor, and therefore poor movement experiences. Low muscle tone creates a difficulty in generating the kind of sustained, controlled efforts required for smooth transitions between positions and graceful, efficient operation of extremities. Characteristics of hypotonia include a lack of pelvic control, increase in lumbar lordosis, hyperextension of middle joints, proximal muscle weakness throughout pelvis, hips and shoulders and increased stiffness in movement patterns and postures (Murray-Slutsky & Paris, 2000). Problems with muscle tone give children with ASD an appearance of being floppy, weak and generally unresponsive to touch, as well as sitting or standing in odd positions (Lord, 1997).

Motor planning (praxis) is the process that is required in order to learn a skill and the conscious attention and effort required to master a new activity (Murray-

Slutsky & Paris, 2000). Motor planning deficits have become an area of interest since several studies have demonstrated that children with ASD exhibit difficulties with aspects of praxis (Gidley Larson & Mostofsky, 2006; Jasmin *et al.,* 2009*;* Miyahara, Tsujii, Hori, Nakanishi, Kageyama, & Sugiyama*,* 1997).

Dyspraxia describes children with motor planning problems and coordination difficulties. These children find it difficult to learn a new task and they require more repetition than others to learn the motor plan. Dyspraxic children show marked impairment in motor coordination, which interferes with daily living. These coordination difficulties are not due to a general medical condition, such as cerebral palsy (Murray-Slutsk

y & Paris, 2000; Portwood, 1999). These deficits are often mistaken for general clumsiness (Baranek, 2002; Gillberg & Coleman, 2000), however children with dyspraxia can be identified with specific characteristics including (Portwood, 1999:17):

- “Poor articulation,
- Difficulties with dressing and feeding,
- Limited concentration,
- Inability to follow instructions,
- Inability to record anything on paper
- Heightened sensitivity to sensory information and
- Poor figure-ground awareness.”

Dyspraxia has been suggested to explain autism-specific difficulties with imitation. Poor body awareness of children with ASD might contribute to their difficulties with praxis in terms of planning and executing imitative movement (Rogers *et al.*, 2005). In the context of the developmental disorder of autism, the dyspraxic deficits could be secondary to a fundamental problem with acquiring motor skills, i.e. motor skill learning.

Studies by Gidley Larson and Mostofsky (2006) have shown impairments in motor learning in autism. Motor learning is a process in which the capacity for motor performance is changed permanently. It is the end product of experience

and practice of a motor task (Murray-Slutsky & Paris, 2000). Deficits, beyond basic aspects of motor coordination, have been exhibited in motor response and planning, and children with autism have demonstrated abnormally slow reaction time for movement preparation (Gidley Larson & Mostofsky, 2006).

Most children with ASD have immature patterns in bilateral movements and a discrepancy between actions of the upper and lower limbs cause problems in coordinating movements (Lord, 1997). A variety of disturbances, in children with ASD, has been observed in action, posture and tone while standing and walking. Unusual gait components have been identified as:

- Slower pace,
- Decreased stride length,
- Increased stance times,
- Increased knee flexion,
- Increased hip flexion at toe-off,
- Ankle dorsi-flexion at ground contact and
- Unusual upper extremity positions during walking.

Gait differences resemble those of Parkinsonian patients and as a result of this observation a dysfunctional motor system involving the basal ganglia has been identified as a possible cause (Maurer & Damasio, 1982; Vilensky, Damasio & Maurer, 1981).

A study done by Hallet, Lebiedowska, Thomas, Stanhope, Denckla and Runsey exhibit similar gait differences in adults with ASD specifically mild clumsiness, upper limb posturing, decreased range of motion of the ankle and decreased knee flexion in early stances. Aspects of gait such as velocity of gait, step length, cadence, step width, stance time and vertical ground reaction forces were presented normally in the ASD group. Therefore it was proposed that the deficit was not of the parkinsonian type but rather cerebellar in nature. Further research to understand the brain-behaviour mechanisms in motor movements in autism needs to be completed (Jansiewicz, *et al.*, 2006).

Berkeley *et al.* (2001) assessed the locomotor skills of children aged six to eight years with ASD. Their results supported previous claims that children with autism have difficulty in motor tasks. Overall fundamental skill delays were demonstrated by 73% of all participants, placing them in the poor and very poor performance categories of the Test of Gross Motor Development (TGMD). Eighty percent of the children had locomotor scores that would label them as delayed in this area. With regards to change in motor maturity, children with ASD exhibit a slower rate of development of walking, supine lying and sitting when compared to typically developing children (Ozonoff *et al.*, 2008).

“Clumsy, uncoordinated, lack of attention, hyperactive” are all words that have been used to describe a child with ASD. Ghaziuddin, Tsai and Ghaziuddin (1992) found that 50% of studies on motor function in children with ASD reported clumsy, uncontrolled movement patterns. However, these may all be due in part to a deficiency in motor control. Impairments in motor control do not follow a predictable course and may not be identifiable in all children. Many researchers believe that within the cerebellum in children with autism, there is a failure of development. This occurs within the first few months after conception or during the first and second years of life. The cerebellum is in control of coordinating complex movements and is essential for balance, fine motor control and muscle coordination (Murray-Slutsky & Paris, 2000).

The impairments in movements ranging from fine to gross motor apraxia to the planning and execution of skilled motor sequences all place high demands on neural integration. Since these deficits form an integral part of the autism syndrome, this evidence suggests that the neural abnormalities for autism are not restricted to the neural systems involved in social, language and reasoning abilities. The presence of these motor deficits, as well as sensory deficits, suggest a more general involvement of neural circuitry. Perhaps it is related to a disruption of the general “cytoarchitectural feature” of the brain organization, which is required for higher levels of information integration (Minshew *et al.,* 2004).

A recent study by Jasmin *et al.* (2009) looked at the impact of sensori-motor skills on the performance of daily living skills (DLS) in 35 pre-school children

with ASD. Mean scores of the children with autism revealed significant gross motor delays and poor fine motor skills. The worst performances were observed in locomotion, object manipulation (i.e. ball skills) and grasping. The researchers looked at various explanations for these poor performances and listed an impairment or deficit in general praxis as one possible justification. These results support previous findings that children with ASD present motor planning difficulties. The researchers were also able to conclude that children with ASD experience severe difficulties with their DLS. This is related to and caused in part by their atypical sensory responses and motor difficulties, especially their fine motor difficulties.

Gillham, Carter, Volkmar and Sparrow (2000) investigated the ability of the Vineland Adapted Behaviour Scale to identify children with ASD. They were concerned with how little guidance was given by traditional diagnostic schemes on how to incorporate information about developmental levels when making a diagnosis. The findings demonstrated a deficit in communication and socialization with children with ASD and more relevant to this study, children with autism displayed poor DLS and serious maladaptive behaviours.

Children with ASD who have communication and social skills may be more likely to participate in early childhood activities with typically developing children. The success of this interaction on the playground may be influenced by how well fundamental gross motor and play skills are performed. A successful performance of these skills will increase the likelihood of the child being asked by peers to join in an activity, as well as being able to remain involved (Berkely *et al.,* 2001). Social isolation from peers prevents the creation of social relationships, which is vital for early social development. Not only could poor motor coordination limit opportunities for successful participation in physical activities with peers, it could also place these children at risk for developing sedentary lifestyle associated diseases (Pan, 2009).

Gross motor skills including kicking, jumping, balancing and ball skills as well as fine motor skills including eye-hand coordination, drawing, cutting and threading all develop during the pre-school years. These complex skills demand a higher level of motor planning abilities and are often learnt through motor imitation.

Young children learn these motor skills and social skills, as well as much of the play of preschool games while interactively playing with each other. Success in these interactions will depend on how well the children with ASD are able to perform fundamental motor and play skills (Provost *et al.*, 2007). Pan (2009) suggests that children's movement problems will only increase as play becomes more complex and rule-bound, especially since children with ASD have difficulties understanding social cues.

The first stage in social-cognitive development of children is the sensori-motor period. Since exploratory activities influence perceptual learning it is essential to firmly establish this foundation in order to facilitate the acquisition of later milestones (Jasmin *et al.*, 2009). To achieve this goal, individual assessments of each child should be developed, the special needs identified and specific intervention plans created. Children with ASD should receive complete developmental evaluations that include assessment of their motor functioning. This is essential in order to provide a holistic intervention program that aids and assists the development of all facets of autism.

Physical Activity, Fitness and Exercise

Physical activity is defined as the amount of movement an individual participates in on a daily basis (Rowland, 2001). During the childhood years physical activity decreases steadily and this can be measured in terms of calories expended. Altering one's level of activity is potentially easily achieved if motivation and encouragement to adapt existing activity levels exists (Rowland & Freedson, 1994).

While physical activity is considered a behaviour, physical fitness is considered an attribute and can be defined as how well an individual can perform on an exercise task (Rowland, 2001). It is much harder to improve physical fitness during childhood and requires the child to participate in a training program of relatively intense exercise, (focusing on strength and aerobic domains) several times a week for several months (Rowland & Freedson, 1994).

Since physical activity can be characterised as bodily movement that produces a contraction of skeletal muscle and substantially increases energy expenditure, it then becomes an all encompasses term that includes exercise, sport, dance and leisure activities. However, exercise is commonly undertaken with the intention of developing physical fitness and health (Tomson, Cuddihy, Davidson, & Pangrazi, 2007).

Benefits of physical activity for adults and children

By adopting a physically active lifestyle, there are a wide variety of health and performance benefits that a neurotypically developing individual will obtain. These include an improvement in physical and psychological health status as well as enhanced physical and mental performance (Haskell, 1987). It has been well documented that physical activity benefits emotional health, reducing anxiety, stress and depression as well as having a positive effect on the treatment of obesity, hypertension and osteoporosis. A physically active lifestyle affects neuromuscular functions and bone density positively and improves physiological function at any age. Physical fitness plays a role in coronary heart disease and more essentially in the musculoskeletal domain (Rowland & Freedson, 1994).

While regular moderate exercise counters the life-shortening effects of coronary heart disease risks, more vigorous exercise can extend the life of an adult individual by several years and reduce the risk of dying from heart disease, stroke, high blood pressure, type 2 diabetes, cancer and other medically-related maladies (McArdle, Katch & Katch, 2001).

Other benefits that have been reported are alleviation of back pain, maintenance of bone mineral content with aging and an enhanced psychological status, including improved self-image, confidence and decreased anxiety, depression and hostility (Haskell, 1987).

The importance of physical activity to overall health for all individuals has been well-documented and increasing physical activity among the youth is a critical, national health objective. Regular participation in physical activity reduces risks

for morbidity and mortality associated with chronic disease such as cardiovascular disease, certain cancers, diabetes, obesity and multiple cardiovascular disease risk factors observed in youth (Pan & Frey 2006).

Byrne and Hills (2007:50) have stated that “physical activity should be an integral part of normal growth and development for all young people... Early in life, particularly in infancy and early childhood, physical activity has an important role in the physical, psychosocial and mental development of the child.” Physical activity also leads to positive self-esteem and behaviour, happiness and intellectual and social outcomes in youth (Pan & Frey, 2006).

In order to provide the greatest chance of developing motor skills needed for participation in life and sport activities, self-initiated informal play is essential as this is where the neurotypically developing child will discover and experience a range of useful physical activities. Movement and physical activity during play are critical to motor development in children and are just as important to the learning process as cognitive activities (Sprinkle, 2004).

There is an impressive accumulation of research data documenting the importance of exercise for health and well-being among the adult population, and the effect that exercise has on adult illnesses such as hypertension and cardiovascular diseases. Although research mostly focused on benefits for adults, “normal” children were encouraged to participate in exercise programs and there have always been efforts to improve their exercise habits through sport, physical education and healthy habits. These ideals have been developed from a strong rationale that physical fitness and activity in the paediatric age group provides a means of diminishing the impact of adult illnesses (Rowland, 2001). Pate and Blair (1978:251) introduced this concept and reasoned their support on the following statements:

1. “While the clinical outcomes of atherosclerotic vascular disease appear in the adult years, the process of atherosclerosis is a life-long one with the origins in the paediatric years.”
2. “It has been clearly documented that adults who exercise regularly carry a reduced risk for atherosclerotic disease and its complications.”

3. “It follows, then, that promoting exercise habits in children to ameliorate the atherosclerotic process beginning at an early age should be expected to serve as an optimal strategy for the prevention of clinical cardiovascular disease in the adult years.”

Other researchers agree with this rationale that if a modifiable factor (physical exercise) can ameliorate a disease state that begins early in life (although clinically silent), the best hope for an effective preventive strategy would be to promote the factor during the childhood years (Rowland & Freedson, 1994).

More recently the health benefits cited for physical activity for young people includes the prevention of overweight and obesity, improvement in skeletal health, enhancement of heart and lung function and better psychological health. Physical activity and exercise also contributes to a lower risk of obesity, coronary heart disease, hypertension, type 2 diabetes, colon cancer, osteoarthritis, and osteoporosis in adulthood (Byrne & Hills, 2007; Gavin, 2009; Kodish, Hodges Kulinna, Martin, Pangrazzi & Darst, 2006).

Two primary goals to consider for children’s exercise include firstly to increase the child’s health related activity and secondly to increase the likelihood that children will be active voluntarily and develop into active adults (Fox, 1991). Ideally, there should be an establishment of healthy lifestyle practices during childhood and a tracking of regular physical activity participation into adulthood. Due to the many benefits it never is too early to foster appropriate activity opportunities (Byrne & Hills, 2007).

In order to provide a physical education program that appeals to children it is important to provide both intrinsic incentives such as having fun, improving skills and enjoying the excitement of the game and extrinsic incentives such as winning prizes, games or pleasing their parents. Programs should provide the right kind and amount of success, even if assistance is required for that child to achieve the success. The program should provide appropriate reasons to be active (Fox, 1991).

Physical activity recommendations for children

For all typically developing children two years and older, the recommended duration of active involvement is a minimum of 60 minutes per day of moderate to vigorous physical activity/exercise (Byrne & Hills, 2007; Pan & Frey, 2006; Rosser Sandt & Frey, 2005). These recommendations should not focus on weight management or other specific health benefits but rather on significantly increasing the amount of physical activity. Children become less active as they mature, so assuring that youngsters receive 60 minutes a day accounts for a likely decrease in activity levels as they age (Tomson *et al.*, 2007).

Gavin (2009) recommends that physical activity for infants (less than 12 months of age) should encourage motor development, while toddlers' minimum daily activity should include 30 minutes planned activity and 60 minutes unstructured free physical play. For preschoolers the amount of unstructured activity remains the same, while the amount of planned physical activity increases to 60 minutes per day. Children at a school-going age should be physically active for at least an hour. Infants and young children should not be inactive for prolonged periods of time (no more than one hour unless they are sleeping) and school-age children should not be inactive for periods longer than two hours. These recommendations are made with reference to advancements in technology resulting in children watching television or playing computer games for long periods of time. Opportunities for young people to participate in physical activity and daily exercise can be found in school physical education, sport facilities and clubs, play settings, active transport and commuting such as walking and cycling, recreation and planned exercise (Byrne & Hills, 2007).

While regular physical activity has been associated with the maintenance of optimal metabolic functioning and the prevention of chronic diseases, there are related benefits of regular weight-bearing activities. These include contributing to the maintenance of skeletal health and desirable body composition by controlling weight and minimising body fat (Byrne & Hills, 2007).

The majority of current evidence indicates that prepubescent resistance training is safe and effective in developing muscular strength and endurance.

Resistance training includes the use of multiple forms of resistance while performing different exercises. Benefits of resistance training for children include: (Haskell, 1987; Roberts, 2002):

- Prevention of cardiovascular disease,
- Reduction and control of hypertension and childhood obesity,
- Retention of lean body mass,
- Improvement of basic motor skills,
- Possible prevention of injuries,
- Improved self-confidence and self-image,
- Early development of good posture,
- Greater ease and efficiency of performing motor tasks and skills,
- Better performance on nationwide fitness tests,
- Early development of coordination and balance,
- Improved flexibility and
- Favourable improvements in body composition.

Stretching exercises can help improve flexibility and aid movement of muscles and joints to bend and move easily through their full range of motion (Gavin, 2009).

Physical activity recommendations for adults focus on the energy expenditure required to maintain general health and fitness, but predominantly maintaining cardiorespiratory or aerobic fitness. For children, it is important to gain experience in all areas of physical activity for all components of health-related physical fitness, and not limit it to only aerobic or cardiovascular fitness.

Physical activity and motor development

The foundation for motor learning in children and the subsequent development of progressively more complex skills, occurs during the early years of life. It is during this time that an individual who is physically more active is more likely to have the opportunity to refine their motor skills. It is through active play that children develop the fundamental movement patterns, such as crawling, standing, walking, running and jumping. Children who have restricted physical

activity may jeopardise their skill development and body composition due to a lower level of energy expenditure. Movement is essential in the exploration of the child's physical capabilities and surrounding environment. Much enjoyment is experienced by children while participating in progressively more vigorous and physically challenging activities (Byrne & Hills, 2007).

Physical activity and children with autism

The Autism Society of America (Pan & Frey, 2006) explains that youth with ASD may be at risk for inactivity due to social and behavioural deficits often associated with the condition. These include understanding social cues, making eye contact, playing imaginative and social games, engaging in sharing/turn-taking and reciprocal conversation and making friends. Since most typically developing youth are physically active with their peers, social and behavioural deficits could limit opportunities for individuals with ASD to participate in physical activity. There are few published physical activity studies that include children with ASD and it is clear that this population has been neglected from the physical activity literature. However, experienced researchers have found it reasonable to assume that the general physical and mental health benefits of physical activity would also extend to youth with ASD (Pan & Frey, 2006).

One of the few attempts to examine physical activity levels and patterns of youth with ASD was completed by Pan and Frey (2006). The results show that youth with ASD are less active than their peers without disabilities and that youth with autism are at similar risks for health problems associated with inactivity as those without disabilities. Youth with ASD do not exhibit the same physical activity participation rates as peers without disabilities, which appears to have a negative impact on physical activity levels in this group.

Physical activity is vital for a healthy lifestyle for children developing "normally". With the limited availability of research on how physical activity effects individuals with ASD, researchers have based their arguments that physical activity offers a variety of benefits for these individuals on logic and their knowledgeable, professional experiences (Cooper & Quatrano, 1999; O'Connor, French & Henderson, 2000).

It has been documented that children with developmental disorders, including ASD, demonstrate physical fitness levels that are inferior to their non-disabled peers and reflect a population that exhibit a sedentary lifestyle (Pitetti, Rendoff, Grover & Beets, 2007; Yilmaz *et al.,* 2004). These challenges, including documented motor impairments in children with autism, make it difficult for physical education teachers to fully include children with ASD in general physical education curriculum (Zhang & Griffin, 2007). Therefore it is of primary importance to develop behavioural approaches that will be effective in increasing the physical activity levels of children with ASD. Quality adapted physical activity education and programs need to be developed and delivered to those on the autistic spectrum (Reid & Collier, 2002).

Rosenthal-Malek and Mitchell (1997) investigated and discovered that when participating in moderate aerobic activities children with ASD may experience increases in attention span, on-task behaviour and level of correct responding. The use of aerobic exercise was shown to decrease self-stimulatory behaviours associated with children with ASD, such as body rocking, hand flapping, head-nodding, object-tapping, gazing at lights and mouthing, without decreasing other positive behaviours. Allison, Basile and MacDonald (1991) have shown the use of aerobic exercise in various special populations to reduce aggressive behaviour. Morressey, Franzini and Karen studied the reduction of stereotyped and self-injurious behaviour and the research of Whitaker and Saleem looked at a decrease in purposeless wandering (Rosenthal-Malek & Mitchell, 1997).

A shortage in research studies dealing with attempts to lower self-stimulatory behaviours in children and adults with ASD, prompted Rosenthal-Malek and Mitchell (1997) to assess the effects of aerobic exercise on the self-stimulatory behaviours and academic performance of adolescent with autism. Two preconditions existed for this experiment:

1. The aerobic exercise precondition was conducted in the gym and consisted of warm up stretches and mildly strenuous jogging.
2. The academic precondition consisted of an assortment of academic subjects conducted in the regularly scheduled classrooms.

Results from this study indicate that there was a significant decrease in self-stimulatory behaviour following the physical exercise precondition as compared to the self-stimulatory behaviours following the regular academic precondition. The level of correct responses significantly increased following the aerobic exercise precondition compared to the academic precondition as well as increasing the number of tasks completed during a community-based workshop situation following the aerobic exercise. This confirms the reducing effect that aerobic exercise has on self-stimulatory behaviours as well as having a positive effect on the level of academic performance and work-related performance.

The limited research completed on antecedent aerobic exercise showed significantly reduced undesirable behaviours, including maladaptive behaviours and stereotypic/ stimulatory behaviours. However, similar results were not seen with general motor training. This study was completed on adults with ASD and profound mental retardation. The results suggest that vigorous, aerobic exercise may be a useful tool for facilitating community integration of adults with ASD.

Jasmin *et al.* (2009) have stated that physical activity and exercise, with its many relevant benefits, becomes a vital tool in improving the motor performance and health status of these children. By improving the way these children move, interact with and explore their environments, there is a positive effect on socio-cognitive developments (Jasmin *et al.*, 2009). Physical education at schools for neurotypically developing children has been an integral part of the learning process and has been deemed essential for students with disabilities. However, there have been few physical activity programs that focus on students with autism (Baranek, 2002), as the unique behaviours of these students have created significant challenges to educators (Schultheis, Boswell, & Decker, 2000). It appears that unavailability of physical activity programs is a significant factor in the physical activity behaviour of youth with ASD (Pan & Frey, 2006).

Children with ASD may experience initial difficulties in a physical activity program because of an inability to cope with the variety of auditory, visual and tactile stimuli in wide-open spaces resulting in various behaviours including:

- Over sensitivity to stimuli,
- Deficits in speech, language and cognitive capabilities,
- Avoidance of changes in routine and
- Difficulties in transferring lessons from one setting to another.

In addition children with autism may possess low levels of physical fitness. However physical activity programs for children with ASD promote appropriate behaviours and improve cardiovascular endurance at the same time, a two for one benefit (O'Connor, French & Henderson, 2000).

Adapted Physical Activity (APA)

Physical activity programs for children with autism

The small amount of research studies available have shown that physical activity programs for children with ASD may lead to a decrease in inappropriate behaviours, an increase in level of physical fitness as well as greater enjoyment of physical and recreational activity times (O'Connor, French & Henderson, 2000). Pan and Frey (2006) have identified that children with autism have fewer opportunities for extracurricular physical activities. The competitive focus of community-based programs prohibits successful participation and diagnostic criteria of autism are not always met.

Essentially youth with ASD are in an indeterminate state regarding physical activity participation and, with few segregated programs that address the special needs of this group, children with ASD are likely to be excluded or unsuccessful in integrated activities. Some researchers believe that children with autism are disadvantaged because of societal treatment rather than characteristics of the actual impairment and the lack of support and societal acceptance may limit access to community and education physical activity opportunities (Pan & Frey, 2006).

Children with ASD can learn critical motor skills through appropriate teaching strategies. Effective teaching strategies for children with ASD include response shaping, increasing prompt hierarchy, decreasing prompt hierarchy, constant

time delay and progressive time delay. The primary goal of using these teaching strategies is to provide opportunities for success in learning various motor skills (Zhang & Griffin, 2007).

In order to learn simple movements most children with autism need to be taken through the movement physically step by step, before they are able to do the movement independently. At that point the movement may only be realized for that specific task and not generalized to other similar movements. To learn the proper manner in which to perform many movement skills physical assistance and prompting is very important (Davis, 1990). It is vital for the physical educator to determine the motor skills that the child with ASD must have in order to perform a physical activity successfully (Zhang & Griffin, 2007).

Intensive early intervention may lessen the disability of the disorder (Ozonoff *et al.,* 2008). Given the role that physical activity plays in personal health, family recreation, reducing stereotypical behaviours, promoting social interaction and enhancing self-determination, it is appropriate that APA educators and recreation specialists promote enriching physical activity experiences for individuals with autism (Reid & O'Connor, 2003). Physical education presents an important opportunity to engage in physical activity and more emphasis should be placed on delivery of quality instruction by teachers with proper certification and experience with working with youth with ASD. Availability of resources is not enough and creating access to resources through appropriate programming, staff training and activity modification is imperative for youth with ASD to successfully engage in physical activity (Pan & Frey, 2006).

Rowland and Freedson (1994) emphasize that the establishment of a physically active lifestyle during the paediatric years is best achieved by exposing children at an early stage to enjoyable physical exercise. Similarly with children with ASD, the earlier the intervention is implemented the better the response to the intervention. Teachers and educators need to think about a range of approaches that will be supportive, motivating and encouraging to the child, resulting in the child taking a more active role in their own actions (Lord, 1997). Berkeley *et al.* (2001) stress the importance of early childhood physical educators to understand the social and communication needs of young children

with ASD in order to construct supported learning environments that give children the opportunity to master their gross motor skills. Pan (2009) indicated that the structured, supervised setting of an APA program allows for an ideal opportunity for the promotion of children's social engagement.

Given the variability in developmental profiles of children with ASD, comprehensive assessments of each child need to be completed in order to determine the basis for service decisions. There is not a "one-size-fits-all" treatment for the diagnosis of autism and motor interventions must be prescribed in an individualized manner consistent with the functional goals of the child (Baranek, 2002). Individual personality traits must be considered when examining physical activity behaviour and it is important to understand that autistic traits are part of the individual (Pan and Frey, 2006). Making a gross motor assessment an integral part of the educational program is essential. The adapted physical education specialist can assess gross motor skills and can also collect and share supplemental information about (Davis, 1990):

- Communication skills,
- Behaviour management strategies,
- Teaching techniques,
- Motivators,
- Frustrators,
- Play skills,
- Interaction skills and
- Coping skills.

Challenging behaviours of children with autism can interfere with the ability to learn and educators need to discover effective ways of managing these behaviours. A reactive approach to these behaviours, such as a verbal reprimand or time-out, may result in further maladaptive behaviours and aggression. It is recommended to connect the child's interests and behaviours to the physical activity. For example, if the child exhibits pacing or hopping movements include these into the APA program. The child will benefit from the physical stimulation and targets of the APA will be met (Zhang & Griffin, 2007).

Examples of APA programs for children with autism

Adapted physical activity (APA) has been defined as (Hutzler & Sherrill, 2007:8):

> a) “the body of knowledge that enables the creation of active living opportunities,” (b) “a set of attitudes and behaviours that leads to the participation of people with a disability in sport and physical activity,” and (c) “apart from the practice of adaptation, APA is a profession, a scholarly discipline, a service delivery system and sometimes a program.”

It is through these APA programs that exercise and physical activity become accessible to children with disabilities, including children with ASD.

There are not many APA programs for children with ASD that have been designed and assessed, and future research is essential. However an internationally known program has been developed. Schultheis *et al.* (2000) aimed at presenting a physical activity program that has been successfully used with students with ASD. They named this program Success in Physical Activity (SPA). This program was based on adaptations of TEACCH and focused on physical fitness and motor ability.

Schultheis *et al. (*2000) discovered that providing appropriate education for individuals with disabilities can be a difficult challenge. Some of the difficulty can be alleviated by adapting the three components of TEACCH, i.e. physical structure, schedules and task organization. The key to ensuring success using the TEACCH method was to remember that each student is an individual and the program must be adapted to their needs. By incorporating this TEACCH philosophy of individualization and the three components, the researchers were able to use SPA to provide a rewarding and effective learning experience in physical education for students with autism. Keeping in mind the main objective in physical education for individuals with autism is to provide opportunities for them to develop the skills necessary to play games and activities with their peers-those with and without disabilities.

Individual or dual activities for children with ASD present several advantages compared to traditional team sports such as basketball or baseball. These

include fewer existing social demands, fewer people required to participate, activities that are more easily continued into adulthood, the rhythmic nature of many individual activities are conducive to repetitive traits often associated with ASD and activities can be performed using family resources (Pan & Frey, 2006).

Pitetti *et al.* (2007) determined the efficacy of a nine-month treadmill walking program on the exercise capacity and weight reduction for adolescents with severe ASD. The protocol for the treadmill program was based on the individual's ability. The end result was a significant increase in mean monthly treadmill walking frequency, speed, elevation and calories expended, coupled with a reduction in body mass index. This indicated that a treadmill walking program could improve or control health profiles of individuals with autism.

Yilmaz *et al.* (2004) also looked at the effects of a training program on physical fitness in autism. These researchers analysed how a water orientation and a swimming training program impacted a nine-year old subject. Results of this study showed the training program to be effective for the development of physical fitness and water orientation capabilities. Swimming should be considered a valuable addition to education programs as it is both enjoyable for the subject and contributes to motor development.

Dance and drama has also been used in an APA program to develop self-awareness, proprioception experiences and social interaction play. Professionals experienced in this field have assumed that by exploring movements through dance children with ASD are able to develop a movement vocabulary for their own use. Dance and drama has been considered as a tool to assist children with autism in various areas such as coordination, flexibility, muscular strength, agility and cardiovascular response (Lord, 1997).

Vigorous jogging programs have been shown to reduce stereotypical behaviours of individuals with ASD immediately after implementation. These behaviours included body rocking, hand flapping, finger flexing, pulling hair and biting (Levinson & Reid, 1993). Physical activities can include any rhythmic, large muscle activities that are continuous in nature such as running, hopping,

jumping, tricycling and cycling. Levels of activities and subsequent increase in performance are dependent on the initial fitness of the child as well as the child's ability to adhere to the activity program (O'Connor, French & Henderson, 2000).

Instructional considerations for developing APA programs for children with autism

Before children with ASD are able to acquire specific skills and participate in an activity independently, they will need several APA sessions with a skilled instructor or trained parent. It is essential for the APA program developer, when selecting tasks for these sessions, to base their selection on the individual's interests and strengths and include tasks that are developmentally age-appropriate. The developer must be aware of what other children are interested in within the community and what the parents are concerned about. All activities have social and cognitive demands and these must be matched to the participant. For example, a lower functioning individual may not be able to participate in an activity that is very complicated and requires a lot of social interaction, e.g. basketball (Reid & O'Connor, 2003).

In an attempt to foster independence for the students TEACCH emphasized the use of physical boundaries and the importance of establishing definite boundaries. The students are more able to identify and carry out assigned tasks when visually clear boundaries designate the exact space that is available for specific activities. Schedules, as used by TEACCH, present assigned activities and indicate the order in which these activities are to be done (Schultheis *et al.,* 2000).

O'Connor, French and Henderson (2000:22) give the following guidelines for providing physical activity for children with ASD:

- Inappropriate behaviours should be initially overlooked as it is more important to provide access to increased physical activity than address behaviours,

- Using creative teaching techniques may increase participation of children with ASD and
- Using task variations between new skills and mastered skills will result in a greater retention of previously learned materials.

Reid, O'Connor and Lloyd (2003) state that the goal of an APA program is to describe practices that maximize skill acquisition and participation. It is important, during the session, to allow time for familiarization of the environment and to promote eye contact between the instructor and student, as this is an important component of social interaction. The instructor should use clear language and be aware of sensory preferences of the child. An ideal session establishes a good balance between social skills training and physical activity objectives. Using applied behavioural analysis to teach skills has shown to be very successful. This is due to the structured discrete trial, use of prompts and reinforcement which results in the child feeling safe, successful, motivated and confident to try difficult, novel tasks (Reid, O'Connor & Lloyd, 2003).

Conclusion

Today autism is considered a developmental disorder of unknown etiology with heterogeneous behavioural symptoms. Major symptoms are qualitative deficits in social interaction, communication as well as behaviours and interests that are unusually restrictive and repetitive (American Psychiatric Association, 2000). Movement skills are a formal diagnostic criteria in Rett syndrome but children with autism and Asperger's Syndrome experience movement problems (Reid & O'Connor, 2003).

The important role that physical activity plays in personal health, family recreation, reducing stereotypic behaviours, promoting social interaction and enhancing self-determination makes it essential that adapted physical education teachers and recreation specialists promote enriching physical activity experience for individuals with ASD (Reid & O'Connor, 2003).

With the importance of providing holistic therapy for children with ASD and the limited research available on the effects of physical activity for these children,

adapted physical activity programs providing beneficial support become essential. Physical activity has been shown to be vital in the growth and development of neurotypical children and with the motor impairments in children with ASD, physical activity seems an obvious choice to assist development in children with autism. However literature on this subject is very scarce and more research in the future is required.

Research into the effects of a physical activity program provides opportunities to create and implement model APA programs. However due to the shortage of research assessing the effects of these APA programs on children with ASD, any additional research on this topic becomes a vital, necessary source of information. The diversity in autism will result in a need for a diverse range of adapted physical activity programs. All children learn through movement and a set of confident motor skills will aid and enhance the learning experience.

CHAPTER THREE

METHODOLOGY

The following chapter describes the design of the study and the procedures followed in the implementation of the study. The research will be implemented using a descriptive multiple-case study approach, making use of qualitative and quantitative data.

Design

Creswell (2003) defines three approaches to research. The first is the quantitative approach which uses strategies of inquiry through experiments, surveys and collects data on predetermined instruments. Second is the qualitative approach which uses narratives, phenomenologies, ethnographies, grounded theory studies or case studies. The last approach is a mixed method in which the data collection involves gathering both numeric information with instruments as well as text information with interviews and the final database represents both quantitative and qualitative information.

While quantitative research relies on measurement to compare and analyse different variables, qualitative research uses qualifying words or descriptions to record various aspects (Bless, Higson-Smith & Kagee, 2006). This study makes use of quantitative instruments including the Movement Assessment Battery for Children and Brockport Physical Fitness Test, as well as qualitative instruments including descriptions, observations and interviews utilising the Sherrill-University of Virginia Adapted Physical Education Social Play Behaviour Inventory, a behavioural profile, session notes and a journal kept by the researcher. With the information gathered from all these sources, an in-depth and extensive description of each subject will be given.

Researchers have used the case study research method across a variety of disciplines as this method provides an understanding of a complex issue and can extend or add strength to previous research. Yin (1984) defines the case study research method as an empirical inquiry that investigates a contemporary real-life phenomenon within its real-life context. Sources of evidence when

utilising a case study design include documentation, archival records, interviews, direct observation, participant observation and physical artefacts (Yin, 2009).

A thorough and detailed, descriptive investigation of three children with ASD will be provided by presenting each child by means of a case study (Bless, Higson-Smith & Kagee, 2006). A case study can be either quantitative, qualitative or even a combination of both, and is used to gain in-depth understanding replete with meaning for the subject. It must involve the collection of very extensive data to produce understanding of the entity being studied and it allows an investigation to retain the holistic and meaningful characteristics of real-life events (Burns, 2000; Yin, 2009).

Yin (2009) explains that the decision to use the case study method will depend on the research questions in the study. The more the questions seek to explain some present circumstance, the more relevant the case study method will be. This method would also be relevant the more the questions require an extensive description of some phenomenon. The research questions of this study seek to determine how an individualised APA program can contribute to the motor abilities, physical fitness and behaviour of children with ASD. The testing instruments and the tools used to collect information will provide an extensive description of each case study in order to answer the research questions.

The unique and diverse way in which ASD presents itself in different individuals results in the use of a control group being ineffective. With limited research available on how physical activity affects children with autism little or no age-appropriate norms for comparison were found. In order to determine the effect of the intervention each subject needs to be thoroughly investigated and analysed independently, therefore making the case study method a suitable and applicable research method for this study.

Hypothesis-testing research deals with the general and the regular, but case studies are directed at the understanding of the uniqueness and the idiosyncrasy of a particular case in all its complexities (Huysamen, 2004). One of the purposes of the case study relevant to this study includes the fact that a

case study could be a possible source of hypotheses for future research as they may refute a universal generalisation (Burns, 2000). A multiple-case study will be done closely analysing three children with autism. Yin (2009) considers single- and multiple-case designs to be variants within the same methodological framework and makes no broad distinction between the two.

By replicating this case study with three participants the research results provide a clearer, more robust depiction of the response to the treatment. Another strength of this study is the evaluation of the response of the multiple variables to the ntervention program. Depending on the number of variables that respond to the treatment will determine the strength of the research results.

Procedure

Selection of instruments for gathering data

A variety of instruments were considered in order to determine the most suitable instruments for gathering data. The Movement Assessment Battery for Children (M-ABC) was deemed the most suitable instrument to assess the motor ability component of the research, because the test components were compatible with the research age group and target motor abilities. This test is comprised of tasks that are familiar to the subjects and provides qualitative observations in order to take the behavioural component into context.

The Brockport Physical Fitness Test (BPFT) and AAHPERD Physical Test are both tests for children older than the research samples. However, the BPFT was considered suitable for this research because it was capable of testing individuals with disabilities and tested the specified motor fitness components of this study.

The following instruments were used over a period of time to gather data from multiple sources about each subject.

Movement Assessment Battery for Children (M-ABC)

The M-ABC (Henderson & Sugden, 1992) combines quantitative and qualitative assessment in a unique way and is mainly concerned with the identification and description of impairments of motor function in children. Both in one-to-one or group settings, this test provides information on how well a child performs. There are two assessment components of the M-ABC test:

1. A checklist which provides an economical means of assessing groups of children through the classroom (and is ideal for screening purposes) and
2. A norm-referenced, standardised performance test which provides objective quantitative data on performance.

This test covers a fairly wide range of motor activities and is organised into three components; manual dexterity, ball skills and balance (See Figure 3).

The M-ABC has been used by several researchers assessing children with autism or Asperger syndrome including Hilton, Wente, LaVesser, Ito, Reed and Herzberg (2007), Miyahara *et al.* (1997) and Green *et al.* (2002). The standardised test assesses children between the ages of 4-12 and is divided into four age bands covering 4-6 year-olds, 7 and 8, 9 and 10, and 11 years and upwards. In the present study only the standardised test was utilized and David and Paul, both aged 5 were tested on Age Band 1, while Sarah aged 8, was tested on Age Band 2.

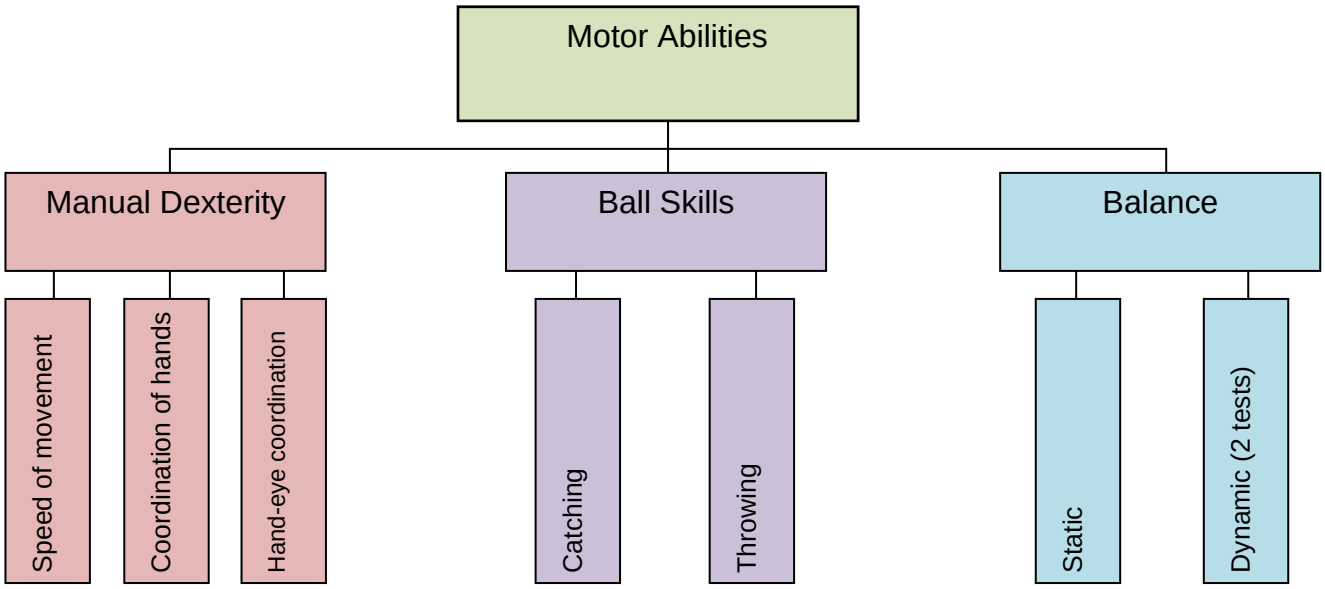

Figure 3 The variables tested by the M-ABC

The M-ABC consists of eight subtests. For Age Band 1 the subtests consist of the following:

Subtest 1: Manual Dexterity- Speed of movement

Posting coins: Child has to place 12 coins into a box with a slot using only one hand. Both hands are tested independently and a score is determined by the number of seconds taken to complete the task.

Subtest 2: Manual Dexterity- Coordination of hands

Threading beads: Child must thread 12 beads onto a string using both hands. Number of seconds taken to complete task determines the score.

Subtest 3: Manual Dexterity- Hand-eye coordination

Bicycle trail: The child must draw a continuous line, following a trail without crossing boundaries. A score is obtained by noting the number of errors that occur. Errors are the number of times the drawn line moves outside of the boundary.

Subtest 4: Ball Skills- Catching

Catching bean bag: Standing 2 meters from the examiner, the child must catch a bean bag using two hands. The score is the number of correctly executed catches out of 10 attempts.

Subtest 5: Ball Skills- Throwing

Rolling ball into goal: The kneeling child must roll a ball between two posts, 40 cm apart, 2 meters from the child. The child must roll from behind the 2 meter line and the examiner records the number of correctly executed goals out of 10 attempts.

Subtest 6: Balance- Static

One leg balance: The child stands on one leg with arms held freely at the sides for up to 20 seconds. The free leg should be bent at the knee and must be kept away from the floor and supporting leg. Swaying is allowed and both legs are tested. The score is determined by the number of

seconds the child is able to maintain balance without committing a procedural fault. These entail placing the free leg on the floor or moving from the original place.

Subtest 7: Balance- Dynamic

Jumping over cord: From a stationary position with feet together, the child jumps over a cord. If the child is able to do this, he/she passes the test. If not after three attempts, the child fails.

Subtest 8: Balance- Dynamic

Walking heels raised: The child walks along the line with heels raised without stepping off the line. Procedural faults include letting the heels touch the floor and stepping off the line. The number of correct consecutive steps executed without procedural fault is recorded.

For Age Band 2 the eight subtests consist of the following:

Subtest 1: Manual Dexterity- Speed of movement

Placing pegs: Task entails the child filling twelve holes with pegs and the time taken to complete the task results in the score.

Subtest 2: Manual Dexterity- Coordination of hands

Threading lace: The child has to lace thread back and forth through a board. Once the lace is through the last hole the time is taken as their score. Threading must be done correctly.

Subtest 3: Manual Dexterity- Hand-eye coordination

Flower trail: The child must draw a continuous line, following a trail without crossing boundaries. A score is obtained by noting the number of errors that occur. Errors are the number of times the drawn line moves outside of the boundary.

Subtest 4: Ball Skills- Catching

One hand bounce and catch: The child bounces the ball on the floor and catches it with the same hand. Both hands are tested. Scores are the number of correctly executed catches out of 10 attempts for each hand.

Subtest 5: Ball Skills- Throwing

Throwing bean bag into a box: The child throws the bean bag into the target box with preferred hand and only that hand is tested. The number of successful throws out of 10 attempts is recorded.

Subtest 6: Balance- Static

Stork balance: The child stands on one foot and places the sole of the other foot against the side of the supporting knee for up to 20 seconds. The hands are placed on the hips and both legs are tested. The number of seconds the child maintains balance without committing procedural fault is recorded. Faults include moving from the original place, moving the non-standing foot from the knee and taking the hands off the hips.

Subtest 7: Balance- Dynamic

Jumping in squares: The child starts the task standing inside the first square with feet together. The child makes five continuous jumps forward from square, stopping inside the last square. The number of correct and consecutive jumps (maximum of five) completed without committing a procedural fault is the child's score. Faults include landing outside of the square, jumping more than once in a square and landing with the feet far apart.

Subtest 8: Balance- Dynamic

Heel to toe walking: The child walks on the line, placing the heel of one foot against the toe of the other with each step. If the child leaves a space between the toe and heel and if he/she steps off the line, the child fails the test. So scores are determined by the number of correct consecutive steps the child takes without a fault.

Raw scores for each subtest are converted to scaled scores, which can then be summed to produce three sub-scale totals and/or an overall total. Both sub-scale and overall total scores will be used to assess the relationship of the variables. Item scores range from 0 to 5 with high scores representing greater impairment. Total scores above 13.5 fall below the 5th percentile and are considered indicative of a definite motor problem. Total scores between 10 and 13.5 span the 5th to 15th percentile range and suggest a degree of difficulty that is borderline.).

Brockport Physical Fitness Test (BPFT)

Winnick and Short (1999:1) state that "the Brockport Physical Fitness Test (BPFT) is a health-related criterion-referenced test of fitness." This test attempts to apply this approach to youngsters with disabilities (both mental and physical), and it recognizes the individualized nature of fitness testing. There are 27 test items in the BPFT, however, only five test items were selected to assess the health-related physical fitness of the children in the study (see Figure 4).

This test is developed to test individuals from the age of 10 to 17 years old and does not refer to children with autism. Therefore, the scores of the subjects recorded during baseline assessment, pre- and post- testing, will serve as indicators for the possible effects of the intervention program.

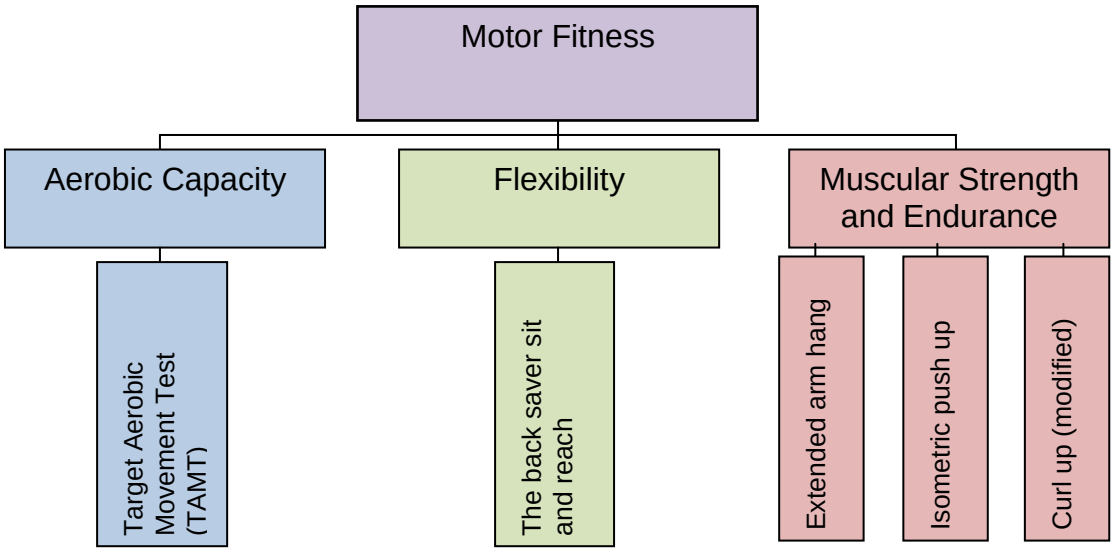

Figure 4 Test items chosen from the BPFT

In other words, a change in the individual's score, over the period of the research, will be analysed in order to determine if there is a relationship between the changing score and the intervention. The five subtests used in the present study include:

Subtest 1: Aerobic Capacity

Target Aerobic Movement Test (TAMT): In order for the child to pass the test, he/she must maintain, through physical activity, a pre-calculated heart rate within a target heart rate zone, for a period of 15 minutes. If the child's heart rate drops 10 beats per minute below his/ her specific zone within the 15 minutes, he/she has 1 minute to raise their heart rate, in order to pass the test. If they are unable to do so, they fail the test and it is documented up to which minute they were able to maintain the targeted heart rate.

Subtest 2: Flexibility

The back saver sit and reach test requires the child to sit with one leg extending out in front of him/her and the other bent at the knee. He/she are then to bend and reach as far forward as possible with both arms with the hands together, palms facing downwards. The child repeats this procedure four times and on the fourth time holds the position in order for the researcher to measure where his/her fingertips extend to on the sit and reach box. The test is then repeated on the other leg. The test score is recorded in centimetres.

Subtest 3: Muscular Strength and Endurance

Extended arm hang: Child must hang unsupported from a bar for as long as possible up to 40 seconds. Score is determined by the time elapsed from the start of the free hang to the time the fingers leave the bar. The test score is recorded in seconds.

Subtest 4: Muscular Strength and Endurance

Isometric push up: Child is to maintain 'up' position in a push up for as long as possible, but up to 40 seconds. Score is determined by the

length of time the individual holds the correct position and is recorded in seconds. Test is terminated if there is movement in the trunk, elbows, knees and shoulders.

Subtest 5: Muscular Strength and Endurance

Curl-up (modified): The child lies supine on a mat with knees bent and places his/ her hands on the front of the thighs. Maintaining a cadence of 3 seconds to perform the movement, the child reaches his hands and sits up to touch his/her knees and then returns to original position. Score is determined by the number of correct sit-ups performed while maintaining the cadence. Once the child is unable to maintain the pace or unable to continue the test is terminated.

Sherrill-University of Virginia Adapted Physical Education Social Play Behaviour Inventory (Sherrill-UVA-APE social play behaviour)

Sherrill (2004) developed a social play behaviour inventory to measure a child's current play behaviours, as well as ongoing improvement in play. With the assistance of the University of Virginia Adapted Physical Activity Program (UVA-APE) this inventory was modified to included four behaviour levels (See Appendix A). The inventory is divided into five developmental levels (see Figure 5).

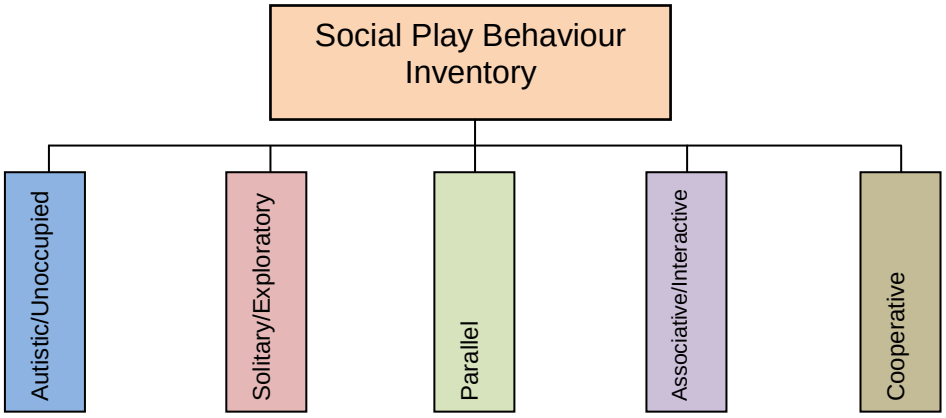

Figure 5 Developmental levels of Sherrill-UVA-APE social play behaviour inventory

The inventory is best completed by an individual who is familiar with the child and the child's play behaviours. For the present study, the researcher has been working with the subjects for several years and was able to complete the inventories accordingly. Although play behaviour is not the primary focus of the present study, this inventory has been included to assess any additional changes that may occur to the subjects' behaviour. Play is dependent on movement and physical activity, and the quality of the play experience is dependent on the success of this movement and activity. If the present study is to research the affect that an APA program would have on the performance of the subject's movement skills, then the researcher would like to establish if this affect on movement will consequently have an effect on social play behaviours.

Behavioural Profile

The effect of improved movement on the daily living activities and overall behaviours of the subjects was investigated additionally. In order to do this a behavioural profile questionnaire was designed (see Appendix B). This questionnaire is to be completed by the parents/carers of the subjects and it focuses on the following areas:

- Daily living activities including eating, sleeping, sitting and standing,
- Levels of arousal and attention,
- Self-stimulatory behaviours,
- Play targets including ability to use physical play apparatus,
- Coping and frustration levels,
- Responses to different environments,
- Maladaptive behaviours and
- Nature and level of locomotion.

Since movement and in some cases the confidence of this movement, forms a critical role in all of these areas, a change in the way the child moves may influence these movement-reliant areas.

Journal

During the intervention period the researcher kept a daily journal. This journal was used to record behaviours of each child, possible reasons for improvement/deterioration of performance and behaviour, notes for future lesson plans, motivators for each child and daily necessary notes that provided vital information. Journal entries were given by the researcher after each intervention session. Daily reflection upon the journal allowed the researcher to make notes and plan future sessions. Once the intervention was completed, this journal provided additional information ensuring a holistic, detailed approach to the intervention.

Selection of subjects

The subjects for this study were a sample of convenience from a population of children who attended an Applied Behavioural Analysis (ABA) centre. This centre accommodated mainly children on the autistic spectrum, however, many children with developmental, behavioural and social impairments attended the centre. The centre also provides therapy at home for these children. The researcher is involved in both the home programs and the subjects' participation at the centre. The researcher's role is one of a therapist, applying the above mentioned therapy. The names of the subjects have not been included in this study and have been replaced with fictitious names. The researcher, for several years, had been working at this centre as well as in the homes of the subjects and many other children utilizing ABA principles for means of therapy. Children were considered for this study if they had:

1. A diagnosis of autism by a clinical psychologist,
2. Basic receptive and expressive communication ability,
3. A tolerance for the gross motor test setting, and
4. Children available for the duration of the research period.

No children over 10 years old or younger than 3 years were invited to participate in this study. This specific age range was established due the researcher's daily observation of children this age with ASD. The researcher noticed how well this age group responded to minimal physical activity and how

further exploration of the effect of physical activity on this age group was needed. Children who had only been in the ABA programme for six months or less were also excluded (their understanding of discrete trials may still have been in development). Once possible candidates for the study had been identified the children's parents/carers were then directly contacted.

Orientation of parents/carers

The nature of the research project was presented to the parents/carers in a meeting, and the researcher provided a detailed explanation of the study and explained the intention to include their child. Sufficient time in the meeting allowed parents to ask questions and also to understand the importance of their participation in filling out behavioural profiles and ensuring their child's availability for intervention sessions. If interest for the child to participate was given, the parents received a letter of information and informed consent (see Appendix C) as well as a brief outline of the research protocol. Time was given after the meeting for the parents to reflect on the opportunity for their child to participate. The researcher was available via email and telephonically. Three families volunteered to participate. After consent was given, the researcher met with the three families again.

In this meeting the researcher discussed the study more in-depth and made arrangements for the session times. Parents were reminded that, at any time during the project, if they were uncomfortable with their child participating, they were able to remove their child without question. Parents were also encouraged to observe any of the sessions, without prior warning to the researcher. During the period of the intervention, parents were given weekly updates about their child's progress and they were able to discuss the impact of the intervention on their child and in their lives.

The subjects who participated in this study had basic language communication skills so the intervention program was explained to them as a fun, play sessions.

Scheduling of testing and intervention sessions

The scheduling for the assessments and the tri-weekly intervention sessions were organised between the researcher and the parents. Sessions were selected on days that the subjects had free periods. The intervention sessions were designed so not to disrupt the child's current therapy sessions. The subjects participated in the program on a voluntary basis and at any stage the child or parent were able to terminate participation. Results of the study were available to any parties concerned or interested. All subjects and their parents/carers were debriefed after the study was completed.

To record the content of these intervention sessions a session target sheet was developed (see Appendix D). Each target variable was listed and the researcher was able to note for each session, what target had been focused on and the subjects performance in that exercise. This provided an uncomplicated technique to record vital session information and ensured no targets were missed and areas of difficulty received attention. This became a crucial source of information for planning subsequent lessons and allowed the researcher to view the child from a holistic point of view.

The format of the target sheet was tabulated and for each target there was a space to record the performance of the child within the target. In order to preserve time and space, letters of the alphabet indicated the child's performance in the exercise:

- I indicated the child was able to complete the task independently,
- A indicated the child require assistance whether it be verbal, visual or physical
- U indicated the child was unable to perform the task,
- N indicated the child was not willing to attempt the task and
- M indicated the child had mastered the skill.

Data Collection

Baseline Data Gathering

Subjects were tested three weeks prior to pre-testing and implementation of the intervention program. This pre-participation information was gathered in order to develop a baseline assessment and was done so in the following ways:

- Baseline testing was administered to subjects to determine motor abilities using the M-ABC, and motor fitness using BPFT. This was completed by the researcher.
- Both tests were administered according to the published standardized directions. Due to the participants' lack of understanding of specific complex instructions, the researcher developed accommodations for these directions. For example, concepts such as "for as long as possible" were difficult to understand and the child would stop before physical ability could be assessed. The researcher found that modelling the task was a more effective direction and the participants understood more clearly what the aim of the task was.
- The MABC and BPFT were administered on the same day however a 25 minute break was given between tests. The researcher found this was a sufficient period of time for the child to recover from the previous test. The MABC was administered first as this test is less taxing on the motor performance of the body as it focuses on concepts like manual dexterity and balance where the BPFT tests aerobic capacity and muscular strength.
- Behavioural profiles were given to the parents of the subjects. These were filled out and returned to the researcher in order to develop a baseline pattern of daily living activities and behaviours.
- The Sherrill-UVA-APE social play behaviour inventory was completed by the researcher for each subject because the researcher has been involved with each subject's personal therapy for several years, a comprehensive and true observation of the child's play skills and social interactions were able to be recorded for the baseline assessment.
- All testing was done at the subject's home at a time convenient for them.

Pre-test Data Gathering

The intervention program was preceded by the pre-testing of all subjects. The protocol followed for the baseline assessment was repeated for the pre-test, i.e. the behavioural profile was completed by parents, the Sherrill UVA-UPE inventory was completed by the researcher, and each subject completed the M-ABC and the BPFT. This information was gathered and compared to scores of the baseline assessment in order to determine if there were any changes during the three week period between assessments.

Intervention

The adapted physical activity program was administered three times per week to each subject. Each session lasted 50 minutes and the intervention continued for 20 weeks. The intervention was implemented by the researcher and was named “Mighty Muscles”. This was done to create a friendly, understandable, accessible concept to the children. Sessions occurred after school or after extra-curricular activities, either at the child’s home or at a near-by recreational facility, like a park or the beach.

1. The program content for each lesson was based on several variables: gross and fine motor skills, endurance and strength training, ball, bat and sport skills, and motor fitness components like balance, agility, flexibility, coordination and power. .
2. Age-appropriate physical play targets included were climbing on apparatus, skipping with a rope, swinging, etc.
3. Initially the Mighty Muscle sessions were designed based on results achieved in the baseline and pre-test assessments. As a result of this the targets of each subject’s sessions were unique and designed with the individuals goals in mind (see Appendix E for Sarah, Appendix G for David and Appendix I for Paul).
4. Once participation in the program resulting in development or improvement of a certain target the content of the session was redesigned to challenge the subject further.
5. This change was based on the participant’s ability to perform the task competently with little strain on the body and with a variety of objects.

(See Appendix F for Sarah, Appendix H for David and Appendix J for Paul). For example, upper body strength training initially involved only using the subject's body weight as resistance. As the subject became stronger and more confident additional free weights were added to the program to develop muscular strength further.

6. With stationary cardiovascular activities, repetitions of these activities were kept to a small number like 10 or 15 repetitions. Once the child became more competent in the task the repetitions were increased.
7. The continual assessing and redesigning of specific targets ensured a progression in the development and mastering of various targets.
8. One of the main objectives of 'Mighty Muscles' was to be fun, enjoyable and encourage the subjects to participate. Besides keeping the activities age-appropriate, the sessions focused on target areas of each child, by disguising the exercise in a game. For example, to focus on endurance and cardiovascular training, instead of just making the child run for several minutes, the researcher would give the child an animal mask and a game of catch or "hunt" would begin. Obstacle courses were set up to focus on various components but would be disguise by creating a fictional setting for the course. The obstacles were referred to as mountains, or rivers that needed to be crossed a certain way. At the end of each session, the child was allowed to choose a sticker from a box. This was utilized as a reward for completing the session.
9. Curriculum decisions were based on improving these motor skills and motor fitness components while ensuring a high level of entertainment and including age-appropriate games and play targets. Each session plan was designed with the individual's needs and abilities as the main focus (see Appendix K for Sarah, Appendix L for David and Appendix M for Paul).
10. All subjects found this extremely reinforcing and worked hard to receive their stickers.
11. The application of behavioural intervention techniques, learnt through Applied Behavioural Analysis (ABA) training, ensured compliance and confidence in areas of difficulty. This provided subjects, who were

unable to perform a particular task, access to a prompt by the researcher, either visually, verbally or physically ensuring success in the task. Reinforcement was still given even if the child was unable to perform successfully.

12. All the subjects were involved in therapy programs that utilised ABA principles, so they were familiar with the techniques.
13. The intervention program was aimed at being performed outdoors and existing structures to focus on target areas were used. For example, stairs were used to improve endurance and leg strength, while stepping stones were used to test agility and coordination. Trees were also used for climbing and upper body strength training. Depending on weather, available facilities and disposition of the child, the program was adapted accordingly.
14. Equipment used for this program included skipping ropes, bats and balls of various sizes and weights, stretchy elastic exercise bands, medicine balls, hand weights, cones, hula hoops and jungle gyms.
15. If at any stage the child experience any discomfort or an unwillingness to continue the session was stopped. Make-up sessions ensured that the intervention continued and on days that rain stopped play outside, the session was done inside the child's home.

Post-test Data Gathering

After the 20-week intervention was completed, the protocol followed for the baseline and pre-test assessment was repeated. This provided the researcher with three sets of data that analysed identical variables but at different stages of the intervention. During the period of testing and implementation of the intervention program no problems occurred with reference the participant's health or behaviour.

Data Analysis

The researcher analysed the effects of the program on the motor abilities, fitness and behaviours of each child on a case-by-case basis. The change in scores obtained by each child in the different assessment settings, i.e., baseline, pre-test and post-test assessment, determined the effect of the intervention program.

The age-appropriate norms and standard deviations provided by the BPFT were not applicable for comparison in this study as all three participants fell below the age category stipulated by this test. With no valid or reliable data from the MABC when applied to children with ASD, the researcher was unable to compare the participants' results with the age-appropriate norms and standard deviations of the test. The nature of the case study does not require comparisons with other groups, but rather an in-depth look at the effect of the intervention on the individual involved.

Decisions were needed for this study to determine the practical significance of changes attributed to the intervention program. The criteria used for indicating improvement observed in the results is as follows:

- A quarter standard deviation was considered a slight improvement in the component
- A half standard deviation was considered an improvement in the component
- A three quarter standard deviation was considered a significant improvement in the component
- Anything higher than the three quarter standard deviationwas considered a definite improvement in the component.

A descriptive report for each child with gathered results, plotted onto graphs is presented in the results. This representation of the data identified the effects the intervention program had on the subjects over the research period. (Each child with autism presents the disorder uniquely and was affected by the intervention differently.) Each subject's case was analysed independently and recommendations were given to each case with the individual child in mind.

Parents were given feedback about their child's performance in the program and future guidelines in order to maintain and progress any achieved developments.

Data analysis of the results will hopefully provide the researcher with additional insight into autism and the role physical activity plays as a therapy for children with ASD. More information about motor impairments, means to address these impairments and the effects of improved motor skills on children with autism is also hoped to be discovered through data investigation. Discovering the nature of the relationship between physical activity and behaviours associated with ASD is an additional goal when examining the results.

Reliability

Reliability refers to the stability, accuracy and dependability of data and is affected by the length of the test and the objectivity of the scoring (Burns, 2000). The researcher has ensured that the methodology is comprehensive and clearly explained and has utilized testing instruments to test motor proficiency that are standardized as well as including the tests for analysing behavioural changes in the Appendixes. Examples of target development and session plans are also included. This will result in other researchers being able to repeat the research protocol of this study and arrive at the same results.

Validity

The central aim of this research design is to determine if there is a relationship between the APA program implemented in the intervention and the motor proficiency and behaviours of children with ASD. The potential of this design to achieve this aim is referred to as the validity of the design and is measured in terms of two separate but related dimensions. Firstly internal validity examines the extent to which a particular research design has excluded all other possible hypotheses which could explain the variation of the dependant variable (Bless, Higson-Smith & Kagee, 2006). The researcher performed a baseline assessment prior to the pre-test to ensure that development or change in the dependent variable was not related to normal development and growth. If changes occurred due to external influences the researcher has documented

this in the individual case study results. For example if the pen grip of a child improved but this was a target of the child's home therapy program, it was mentioned in the results.

Secondly external validity examines the extent in which the results of the study can be generalised. High external validity can be achieved by ensuring that the sample is a representation of the population in question and that the study stimulates reality as closely as possible (Bless, Higson-Smith & Kagee, 2006). As it is evident from the review of literature the spectrum of autism results in each child presenting the disorder differently, making it almost impossible to generalize the results of this sample to the population. The aim of a case study is to scrutinize each case independently, and not to use the results for comparisons.

The testing for the study was performed in each subject's home environment and certain tasks were adapted to suit the subject's preferences. For example in the aerobic capacity test each subject performed endurance activities that they enjoyed and were familiar with. The intervention program also was administered to the subjects in their home or a nearby park that they were familiar with. This resulted in the researcher being able to minimise a whole range of reactive effects. For tasks or stimuli that were novel for the subject the researcher ensured focus was remained on the task or a demonstration was done in order to assist the subject in the task performance.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Once results from the baseline and pre-test assessments were completed the researcher was able to identify weak areas. This information then aided in designing specific APA programs to focus on target areas that were specific to each case.

Each Mighty Muscles session was designed to concentrate on the specific goals of each subject and was continually redesigned as the child learnt, developed, mastered and progressed from each target. Each Mighty Muscle program was unique and specific target areas are noted in each case study.

In the three sessions per week, each session covered different targets and were adapted to the various influences, including disposition of the child, weather, setting for the session and requests from the child.

For the M-ABC a decrease in the test item scores is indicative of an improvement in the performance of the task. For the BPFT an increase in the score achieved indicates improvement in the test.

CASE STUDY ONE- Sarah

Personal Background

Sarah is an eight-year-old girl born in November 1999. She lives with her family and is provided with a very stimulating home environment. Sarah is considered a very low-functioning child on the autistic spectrum and communication is done through a sign-language program called Makaton. Sarah is able to understand instructions and express her needs through this method. Her basic receptive and expressive communication abilities were sufficient for this study.

Sarah displays a variety of self-stimulatory behaviour and has very rigid and obsessive play rituals. She also has a tendency for aggressive, self-injurious behaviour, however she is tolerant of the gross motor setting and enjoys physical stimulation.

Sarah has been involved in the ABA program for several years, attends a centre twice a week and receives home therapy four times during the week. The researcher is involved in both the development and implementation of her therapy program at home and the centre.

She does not participate in any daily exercise programs or organized sport activities. Sarah does exhibit characteristics of low muscle tone, dyspraxia and is generally considered sedentary. Sarah's poor rate of physical activity is a result of minimal supervised, direct physical stimulation and the limited choice to extracurricular activities available to cater for her special needs as a child with ASD. Pan and Frey (2006) identified this lack of opportunity as a determinate for physical inactivity.

Target areas for Sarah's Mighty Muscle sessions include ball skills, manual dexterity, balance, muscular strength concentrating in the upper body and core, endurance training and flexibility (see Appendix E).

Sarah does not attend a school or play group so the effect of the intervention program on school behaviour was not a component that was analysed in this case study. Instead the amount of voluntary physical activity was analysed. Information about this was gathered from the behavioural profiles done on Sarah. Another justification for investigating this component of behaviour was due to the considerable amount of time that Sarah chooses to be sedentary. This component was not investigated in the other case studies as it was not applicable to the other participants involved.

Motor Proficiency

Research question one**:** Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?

Movement Assessment Battery for Children (M-ABC)

Sarah, age eight, was test on Age Band 2.

Manual Dexterity

This battery starts with determining manual dexterity through three specific activities: placing pegs, threading lace and completing a flower trail. A decrease in score indicates an improved performance in the test. The following results were recorded for Sarah.

Placing pegs (see Figure 6)

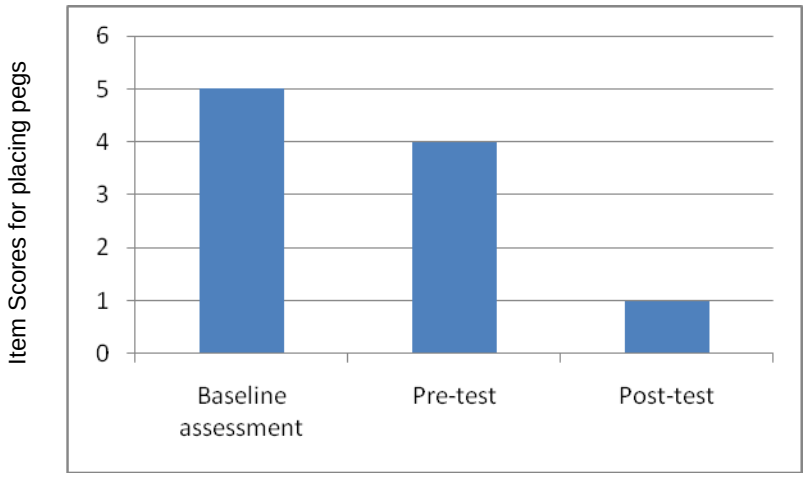

Figure 6 Manual dexterity: Placing pegs for Sarah

Baseline assessment

Sarah has within her therapy program been exposed to task requirements prior to the testing. However possible influences on the score achieved could include the lack of understanding of novel concepts such as “fast as possible”. Intermittent self-stimulatory behaviour was also present resulting in Sarah unable to maintain focus on the task. Her sitting posture was poor and she used excessive force when inserting the pegs. Her method was slow and uncontrolled and she battled to manipulate the pegs.

Pre-test assessment

Although she received a slightly better score for this assessment, Sarah’s method was still poor and disorganized. There were self-stimulatory behaviours present but were not as distracting as in the baseline assessment. Constant fidgeting and excessive force was exhibited during insertion of the pegs. Sarah

did not use her supporting hand to hold the peg board steady or use a pincer grip to pick up the pegs.

Post-test assessment

Sarah performed well in the last assessment and reduced her completion time by almost 10 seconds. There were no disruptive behaviours observed and this allowed Sarah to attend to the task for longer periods of time with more focus. Her method had improved drastically with better control and technique used. She did not use her supporting hand to hold the board still and this resulted in time lost as she occasionally needed to correct the placement of the board.

Threading lace (see Figure 7)

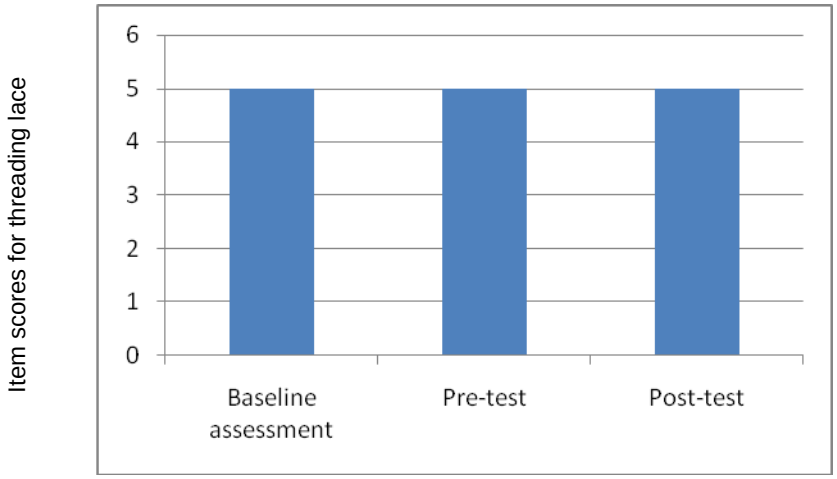

Figure 7 Manual dexterity: Threading lace for Sarah

Baseline assessment

Threading lace onto a board was a novel task for Sarah. The concept was difficult for her to understand and this resulted in her failing the task on the first attempt. After further explanation she was able to pass the task requirements. However, the lengthy period to complete the task, constantly changing her hands during the trial and missing the hole with the tip of the lace resulted in a poor score. Focus was poor and self-stimulatory behaviours added to the long period of the trial.

Pre-test assessment

Sarah failed her first attempt due to her misunderstanding of the sequence of the threading. Her second attempt was correct but again a lengthy process, with completion taking over one minute. Her method was muddled and inconsistent and her behaviours and focus again affected her time.

Post-test assessment

The difficult concept of this task resulted in Sarah failing her first attempt. Her time to completion in the second trial was over one minute and a poor score was received again. Although there was no self stimulatory behaviours observed and she exhibited more control over the lace and no changing of hands during the trial.

Flower trail (see Figure 8)

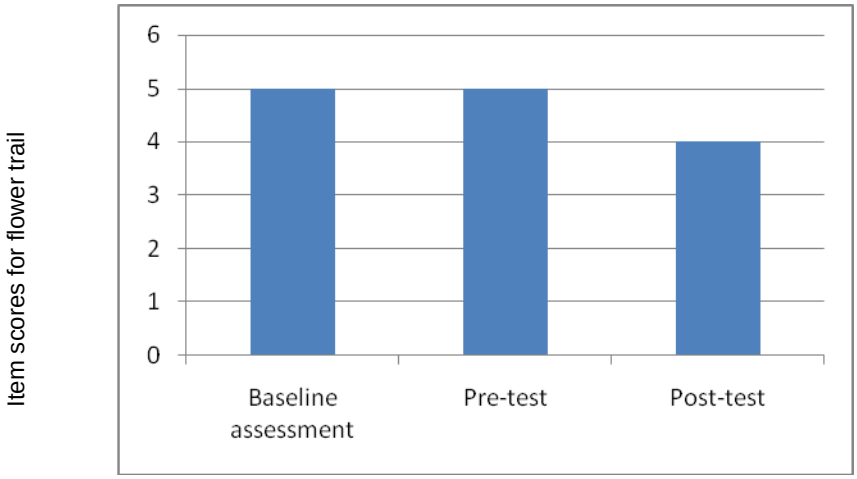

Figure 8 Manual dexterity: Flower trail for Sarah

Baseline assessment

This task required the subjects to draw a pattern within a boundary. Sarah failed her first attempt as she did not understand the concept of drawing in between the lines. Further explanation resulted in her passing the second trial, but numerous errors resulted in her poor score. Her method was “jerky”, uncontrolled and very fast which resulted in poor accuracy.

Pre-test assessment

Sarah passed this task on the first attempt with fewer errors made but there were still enough errors to give her a poor score. Her poor technique was similar to the baseline assessment with short, “jerky”, uncontrolled, fast movements.

Post-test assessment

A much improved technique was observed in the post-test assessment. Sarah used more control over the pen and was much slower. As a result a slightly improved score was received with fewer errors made.

- **Summary of Manual Dexterity tests**

Table 3 Manual Dexterity: Sarah

Baseline assessment	15
Pre-test assessment	14
Post-test assessment	10

The overall test score recorded is a combination of the scores received for all three trials. The improved manual dexterity post-test score is a result of the drastic improvement in the placing of the pegs score. Slight improvement in the flower trail scores and no improvement in the treading lace scores result in only a slight change in the post-test score. The concept of the threading task was not retained by Sarah as she failed the first attempt on all three test situations. Test familiarity was not an influence on this result. Observation notes from the testing settings show a marked improvement in the technique and control that Sarah exhibited in all three manual dexterity tests after implementation of the intervention had occurred.

Ball Skills

To determine ball skills proficiency two activities were used in this test: one-hand bounce and catch, and throwing a bean bag into a box. A decrease in the score achieved indicates an improved performance in the test. The following results were received for Sarah.

One-hand bounce and catch (see Figure 9)

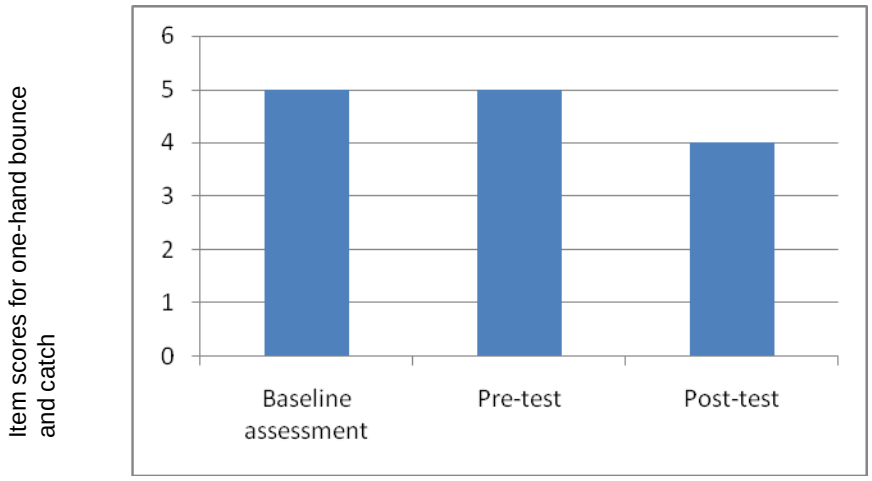

Figure 9 Ball Skills: One-hand bounce and catch for Sarah

Baseline assessment

Sarah was unable to complete this task with a pass score. She failed the task with both her preferred and non-preferred hands and as a result of this she received the poorest score possible. Failure to pass was due to her poor technique which included closing her fingers too late, not adjusting her body for catching, judging the bounce of the ball poorly, not adjusting her feet appropriately and lack of movement fluency. Self-stimulatory behaviours also interrupted her focus on the task.

Pre-test assessment

Sarah failed the trial on both her preferred and non-preferred hand. This was due to similar poor techniques observed in the baseline assessment, as well as the inability to track the trajectory of the ball with her eyes.

Post-test assessment

Sarah was able to pass the trial with both hands and much improvement was observed in her technique. Response time and control over her hands were much better, she adjusted her posture accordingly and tracked the trajectory of the ball effectively. No self-stimulatory behaviours were present and her focus on the task was superior to previous assessments.

Throwing bean bag into a box (see Figure 10)

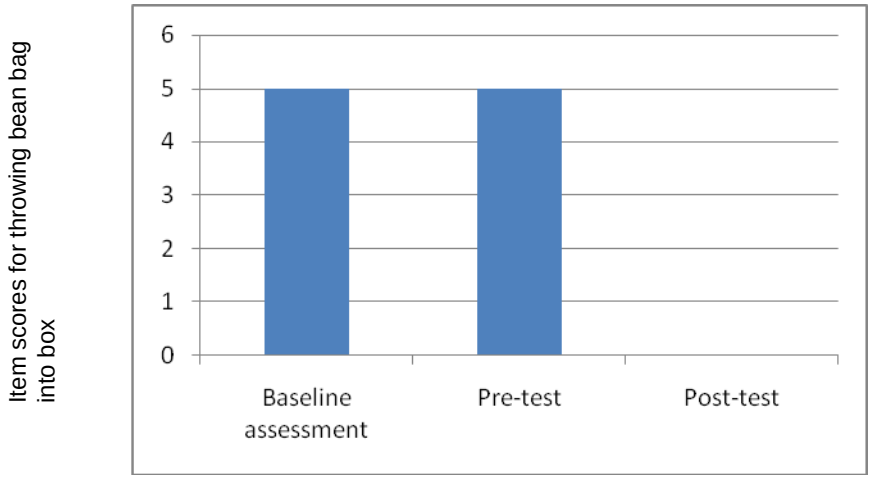

Figure 10 Ball Skills: Throwing bean bag into box for Sarah

Baseline assessment

Sarah was unable to throw the bean bag into the box during this assessment resulting in a poor score. She did not keep her eyes on the target or use a correct method for throwing the bean bag, i.e. no follow through of the arm or pendular swing. There was no rotation of the trunk and hips and she was unable to control or judge the force of her throw.

Pre-test assessment

Sarah was able to throw just one bean bag into the box during this assessment. Technique was still unsuitable and inefficient and her result is indicative of this.

Post-test assessment

Substantial improvement was made in this trial and Sarah received an excellent item score (score of zero). Her technique drastically changed including positive

developments in tracking, aiming and throwing skills and appropriate body adjustments.

- **Summary of Ball Skills test**

Table 4 Ball Skills: Sarah

Baseline assessment	10
Pre-test assessment	10
Post-test assessment	4

After implementation of the intervention, Sarah showed positive changes in overall scores in the post-test assessment. Her definite improvement in throwing the bean bag into the box can be related to improved technique and skills mastered as observed during the assessments.

Balance

The determining of the balance levels as part of the movement assessment in the M-ABC test comprise of three sub-tests: stork balance, jumping in squares and heel-to-toe walking. A decrease in the score indicates an improved performance in the test. The following results were obtained by Sarah.

Stork Balance (static) (see Figure 11)

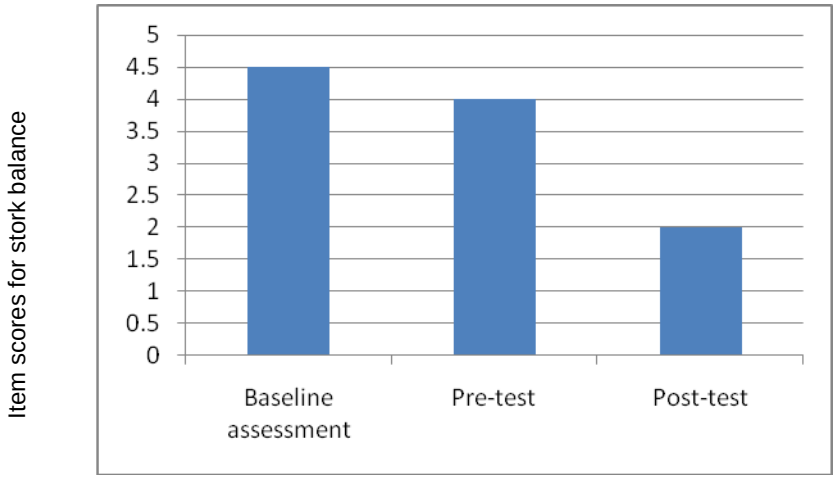

Figure 11 Balance: Stork balance for Sarah

Baseline assessment

Sarah received a below average item score for this trial. This was due to a weak technique including poor body control, not holding her eyes and head steady, making no supporting compensatory arm movements and swaying wildly to try to maintain balance. The exaggerated movements with her arms and trunk disrupted her balance significantly as she was only able to hold the positions for a few seconds.

Pre-test assessment

Similar technique problems were exhibited in the pre-test. Self-stimulatory behaviours, such as finger flicking, disturbed her body control and focus.

Post-test assessment

Sarah was able to hold the position for much longer. She had more control of her arms and trunk and made compensatory movements that aided in her maintenance of the position. Her posture appeared more upright and she was able to manage her body more effectively.

Jumping in squares (dynamic) (see Figure 12)

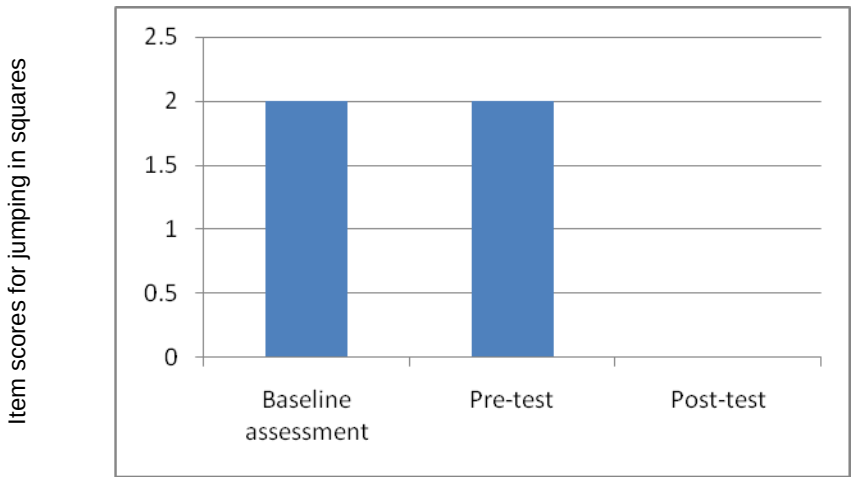

Figure 12 Balance: Jumping in squares for Sarah

Baseline assessment

An average performance was displayed in this trial. Sarah was able to perform a portion of the trial correctly although certain problems resulted in her inability

to complete the test accurately. She did not use her arms to assist in jumping and made no preparatory crouch. She jumped without knee flexion and landed on flat feet.

Pre-test assessment

Sarah performed an exact repeat of what occurred in the baseline assessment. The same poor method resulted in the same item score.

Post-test assessment

Sarah was able to complete the entire trial with complete accuracy (zero item score) as a result of better control of her body, assistance from her arms and an observable preparatory crouch. Her leg movements were more fluid, accommodating and adjusted appropriately to the movement

Heel-to-toe walking (dynamic) (see Figure 13)

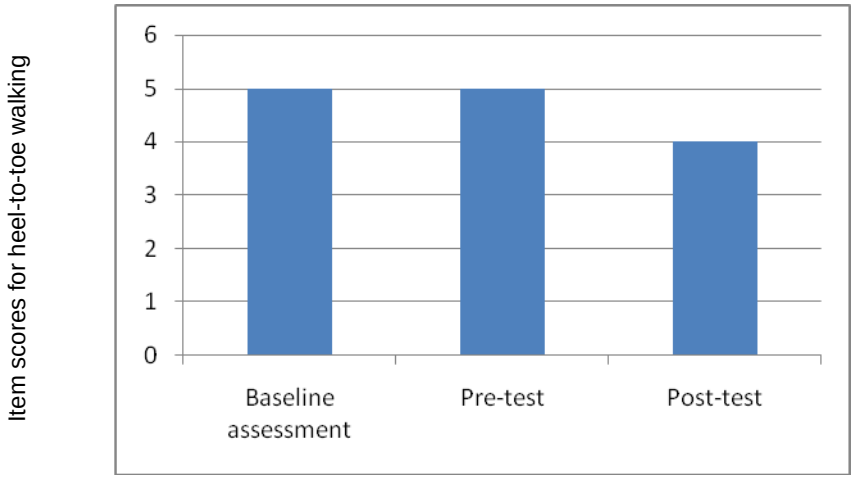

Figure 13 Balance: Heel-to-toe walking for Sarah

Baseline assessment

Sarah struggled immensely with this task and failed all three attempts. She was unable to look ahead and did not keep her head and eyes steady. There were no compensatory arm movements and she was very wobbly when placing her feet on the line. Her body appeared to be limp and floppy and there was no focus during the task.

Pre-test assessment

Failures in all three attempts were recorded and Sarah was unable to walk heel-to-toe. Observations were the same as the baseline assessments.

Post-test assessment

Sarah failed the first attempt in the post-test but was able to walk eight steps heel-to-toe in the second attempt. She still appeared slightly unstable but there was more overall control in the legs, trunk and arms. Her movement was slower, more fluid and more stable. Her focus on the task was better and disruptive behaviours were not present.

- **Summary of Balance test**

Table 5 Balance Skills: Sarah

Baseline assessment	11.5
Pre-test assessment	11
Post-test assessment	6

The total scores received for balance show a definite improvement. Sarah appeared more in control and effective in both production and correction of her movements. Her post-test advancement is a result of the developments Sarah had achieved in learning and mastering balancing skills. The results received in heel-to-toe walking could be due to the dyspraxia that Sarah experiences.

Research question one**:** Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?

The answer to Research Question one can be summarized through Table 6 indicating the overall results on the Motor Proficiency through the use of the M-ABC test for Sarah:

Table 6 Baseline assessment, pre-test and post-test M-ABC Scores for Sarah

	Baseline Assessment Scores	Pre-test Scores	Post-test Scores
Manual Dexterity	15	14	10
Ball Skills	10	10	4
Balance	11.5	11	6
Total Score:	36.5	35	20

The positive improvements in all three motor proficiency areas in the post-test assessment provides a clear indication that the individualised adapted physical activity program contributed to the motor abilities of Sarah.

General observations

Sarah enjoyed participating in the three M-ABC assessments. Self-stimulatory behaviours and a poor focus on the target resulted in some of the time-dependant scores being very low. The concepts of finishing the task “as fast as possible” or to “stay within the line’” were difficult for her to understand. Both her low muscle tone and dyspraxia made performance in all three areas very weak.

There was large improvement in the scores from the baseline assessment and the pre-test to the score achieved in the post-test. The slight improvement between baseline assessment and pre-test scores are due to Sarah’s familiarization of the test procedure. The improvement in behaviour contributed to the improvement in the post-test scores. There was considerably lower ‘stim’ behaviours present and her focus was much better.

The intervention program focused intensely on ball skills and balance tasks and the familiarization and practice with the equipment and similar tasks resulted in an improvement in her post-test score.

All total scores for Sarah fall below the 5th percentile for children in her age group and are therefore considered indicative of a motor problem. However, her movements were more confident and increased strength aided her performance in all areas.

Physical Fitness

Research Question two**:** Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?

Brockport Physical Fitness Test (BPFT)

The BPFT uses aerobic capacity, flexibility, muscular strength and endurance (a total of five test items) to indicate fitness levels of persons with disabilities. An increase in the score of the test item indicates an improved performance in the task.

Aerobic Capacity (see Figure 14)

The following results were obtained for Sarah in the aerobic capacity test. The longer the participation in the activity, the stronger the aerobic capacity of the subject.

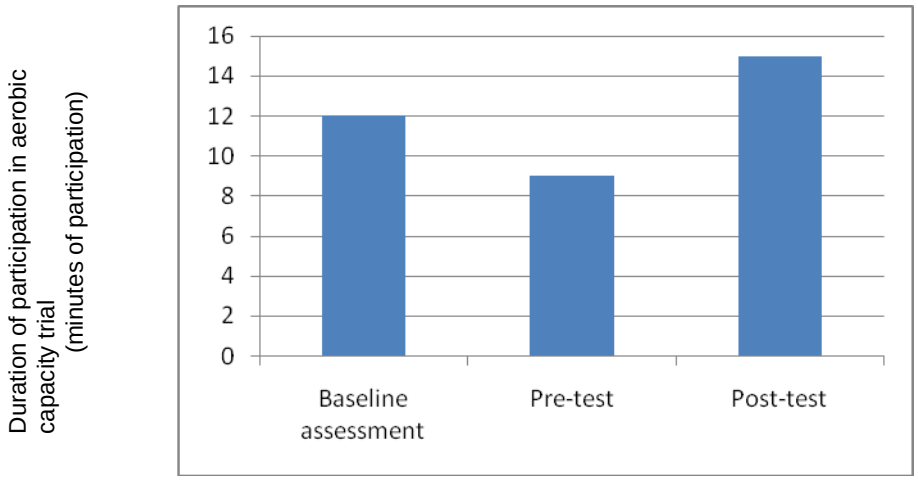

Figure 14 Aerobic capacity: Duration of physical participation for Sarah

Baseline assessment

Sarah was able to continue participation in this trial for 12 minutes, while maintaining the necessary target heart rate zone. After the twelfth minute she refused to continue with the activity and subsequently her decreased heart rate resulted in the completion of the test. Sarah appeared to be flushed, out of breath and in need of a rest and she needed constant encouragement to participate.

Pre-test assessment

Sarah had been experiencing poor sleeping patterns for a few days prior to this testing. She was observed to be more irritable and there was an overall lack of energy. Due to her exhausted state, she refused to continue her participation after 9 minutes. Sarah, similar to the baseline assessment, seemed to tire quickly and after the test required a lengthy recovery period.

Post-test assessment

In this trial Sarah completed the entire test. She was able to continue participating for more than 15 minutes with the appropriate target heart rate zone. She thoroughly enjoyed participating in the test and did not need encouragement to continue participating. After the desired time was reached, she requested to continue the activity. After the test was finished she appeared to be less affected by the activity.

Even though the improvement between the baseline assessment and the post-test scores is only three minutes, the performance observed in the two tests is the true indicator of the results of the intervention program. Sarah appeared more confident, at ease and fitter in the post-test. Her cardiovascular system was under less stress and she was more focused on the activity, than on her fatigue. The researcher ensured that cardiovascular activities were performed tri-weekly and were enjoyable. Sarah enjoyed riding her bike and running on the beach.

Muscular Strength and Endurance

Arm hang (see Figure 15)

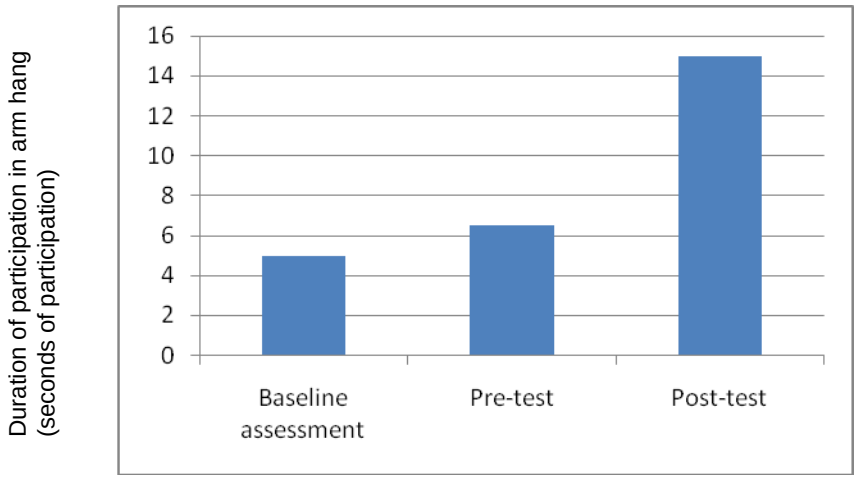

Figure 15 Arm hang: Duration of physical participation for Sarah

Baseline assessment

Sarah was able to hang on the bar for five seconds. She appeared uncomfortable and stressed by the activity. At the time of this assessment Sarah was unable to use the “monkey bars”.

Pre-test assessment

Even though Sarah was able to hang for a slightly longer period of time she still appeared to struggle with this task. After she was finished she was observed rubbing her arm and hands.

Post-test assessment

Sarah was able to double her time spent hanging from the bar and she did this with much greater ease than observed in prior assessments. She looked stable and comfortable in the task and, at the time of this assessment, was able to use the monkey bars suitably and chose to do so in her recess time.

With observable increased strength, Sarah has shown a definite improvement in the capabilities of her upper body and performance in motor tasks.

Isometric push up (see Figure 16)

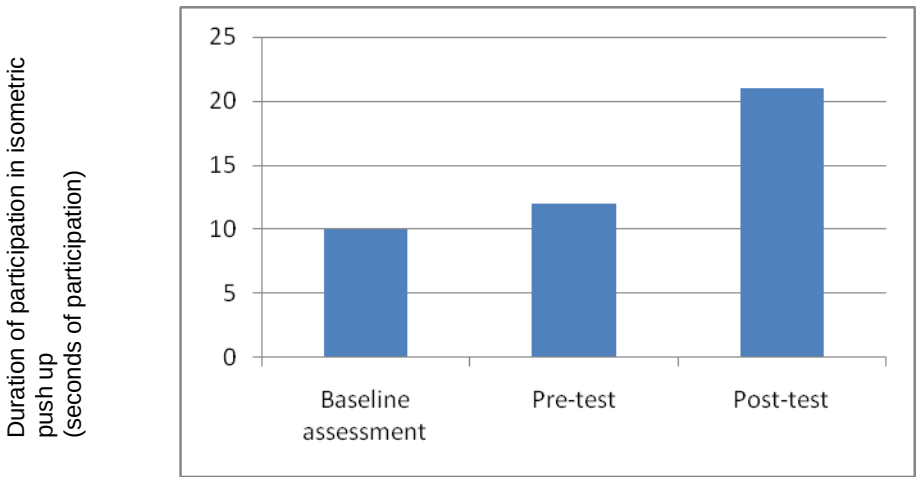

Figure 16 Isometric push up: Duration of physical participation for Sarah

Baseline assessment

The concept of holding the position for a long period of time was an issue for Sarah. However if the researcher modelled the task, Sarah was more likely to imitate and only cease the task when she fatigued. Sarah was observed to strain a lot during the task and did not breathe easily. Once the task was finished she battled to push herself up to standing.

Pre-test assessment

Sarah was able to hold the position for a slightly longer period but was exhibiting the same amount of strain and discomfort.

Post-test assessment

Sarah was able to remain in the required task for an additional nine seconds. The task was performed with less effort and Sarah was able to breathe easily and appeared comfortable.

Curl up (see Figure 17)

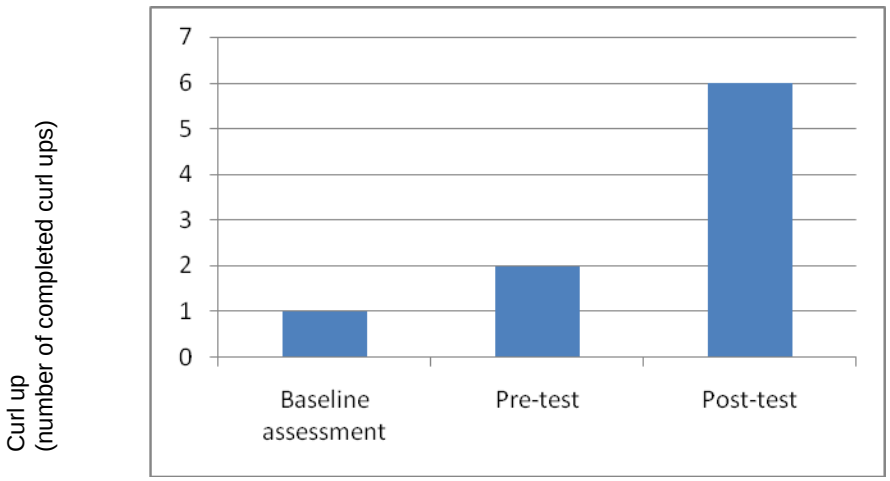

Figure 17 Curl up: Number of completed curl ups for Sarah

Baseline assessment

According the task specifications Sarah was only able to complete one accurate curl up. When performing the second one she needed to use her arms for momentum in order to sit up, however she was not able to do this in the specified amount of time.

Pre-test assessment

Sarah performed two full curl ups in this trial but was unable to sit up at all on the third attempt. She placed her elbows on the ground to assist in curling up and this ended the task.

Post-test assessment

Sarah was able to do six accurate curl ups in the post-test. They were all performed without the aid of her arms or momentum and were performed in the specified time. The first four curl ups were observed to appear strong and secure.

In the final assessment one noticeable change in Sarah, compared to the first assessment, was the method in which Sarah sat up from lying down. Initially when sitting up from a supine position she would roll over onto her elbow, push up on to her knees and use her arms and legs to stand up. After the intervention

program Sarah would sit up directly, without the aid of her arms and then push up to standing from a cross-legged position. The improved strength of her core has also made the time to stand up much quicker and more fluid.

Flexibility

Sit and Reach test (see Figure 18)

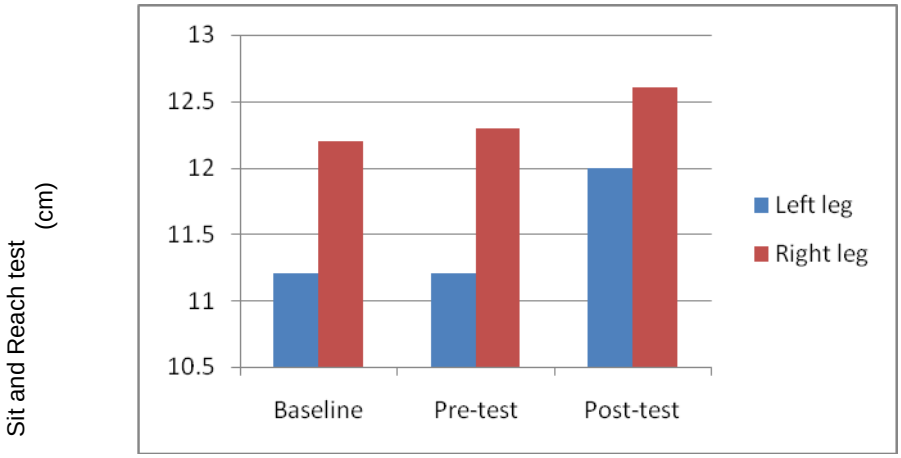

Figure 18 Sit and Reach test for Sarah

Baseline assessment

Sarah exhibited through this task that she has more flexible in her right leg than in her left leg. This task appeared very uncomfortable to perform and she was very agitated while measurement was being taken.

Pre-test assessment

Similar results were received as the baseline assessment and the same observable discomfort and discontentment was noted.

Post-test assessment

Improved flexibility was achieved more successfully on the left leg of Sarah. There was a slight improvement in flexibility of the right leg and the range of difference between the right and left leg is smaller. Sarah presented a level of discomfort but not at the same level as seen in previous assessments.

Stretching and other similar exercises were performed daily by Sarah and she would often request certain exercises during her therapy sessions, seeking the physical stimulation.

Research Question two**:** Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?

The answer to Research Question two can be summarized through Table 7 indicating the overall results on Physical Fitness through the use of the BPFT test for Sarah:

Table 7 Baseline assessment, pre-test and post-test BPFT Scores for Sarah

Physical Fitness Components	Sub-test	Baseline Assessment Scores	Pre-test Scores	Post-test Scores
Aerobic Capacity	Aerobic capacity	Tired at 12 minutes	Tired at 9 minutes	Completed test
Muscular Strength and Endurance	Arm hang (seconds)	5	6.5	15
	Isometric push Up (seconds)	10	12	21
	Curl up (number completed)	1	2	6
Flexibility	Sit and Reach Test (cm)	Left leg: 11.2 Right leg: 12.2	Left leg: 11.2 Right leg: 12.3	Left leg 12 Right leg: 12.6

In this case study the individualised adapted activity program resulted in a positive change in Sarah's physical fitness scores in all three physical fitness components.

General observations

Language instructions again became an issue in the implementation of this test for Sarah. She did not understand "hold the position for as long as possible". So the researcher thought the easiest way to assist with this problem would be to model each test alongside the subject. Sarah's imitation skills are very strong and with the researcher modelling the exercise Sarah imitated as long as her physical fitness could manage.

There was an improvement in all the scores (see Table 7) between pre- and post-tests, with definite improvements in aerobic capacity, arm hang and isometric push up. Slight improvements between baseline assessment and pre-test scores again are due to familiarization of tasks. However the decrease in aerobic capacity was due to physical exhaustion in the pre-test. Sarah was experiencing poor sleeping patterns at the time of the pre-test and was physically less energetic.

Through the results seen in the isometric push up and the arm hang the researcher can add physical evidence to the remarks made in the daily journal. These observations detected an increased strength and confidence in the upper arms of Sarah. At the time of the post-test assessment Sarah is participating in more activities requiring body weight to be supported on the arms, e.g., wheel-barrow races, sliding down firemen poles and balancing on an exercise ball with her arms.

Social Play, Daily Living Activities and Overall Behaviour

Research Question three: Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

Sherrill UVA-UPE Social Play Inventory

Results between baseline assessment and pre-test for the Social Play inventory were very similar.

Baseline and Pre-test assessments

Sarah's play behaviour was described as follows:

- Unoccupied: Sarah often exhibited repetitive, stereotyped behaviour and was self-stimulating. Objects were pounded without purpose and spontaneous play was not often displayed.
- Solitary/Exploratory: Sarah does react to stimuli but not often to persons or objects. She definitely shows person preference, as she is very attached to her family but does not show object preference. There is seldom exploration of toys or body parts.
- Parallel: There is awareness of others but Sarah does not interact and play independently with her own things. Parallel play occurs more by chance then for social reasons.
- Associative/Interactive: Sarah does not initiate play, engage with, share with or interact spontaneously with others. If prompted, she will interact, imitate, take turns and listen to peers.
- Cooperative: Sarah cannot participate in cooperative play.

Post-test assessment

After the intervention program, the following results were received on the inventory for Sarah

- Unoccupied: There was a definite reduction in self-stimulation and repetitive behaviours observed. Sarah has started to exhibit more spontaneous play, with appropriate toys.
- Solitary/Exploratory: Sarah is showing object preference and there are improvements in object and body part exploration.
- Parallel: Sarah is following in imitation games but is still not establishing play areas near others.

- Associative/Interactive: There has been a significant improvement in this area and Sarah is showing more spontaneous imitation and is interacting more confidently with others. She still needs help to engage in communication with others but she has become more competent. On days when the intervention was not administered, Sarah would bring equipment to the researcher to initiate the session. She would also initiate anticipatory games with the researcher.
- Cooperative: Sarah still does not partake in cooperative play independently but with facilitation she may be able to manage it.

Behavioural profile

With regards to the behavioural profile and the daily living activities and behaviours of Sarah, the baseline assessment and pre-test results were very similar again.

Baseline and pre-test assessment

Prior to the intervention Sarah was described as a child who did not enjoy a variety of food and took a long period of time to eat. She would look for additional food after dinner. Sarah battled to fall asleep and would wake during the night. Motivation was required to wake the child in the morning and she was not always happy when waking up. Occasionally she would take naps in the car.

Sarah was described as a fidgety child, who could not remain seated for long periods of time with legs crossed comfortably. She would need assistance to sit with a straight back and did battle to stand still without fidgeting. She enjoyed watching television and would perform unusual movements while in motion, i.e. hand flapping and head banging. With regards to play apparatus, Sarah could not swing herself or use the monkey bars unsupported or hang from these bars. She was able to run, but not comfortably. However when Sarah was not in therapy sessions, her choice of activities included sedentary options such as watching DVD’s, lying on her bed listening to music, or playing with soft toys on a couch (see Figure 19).

Sarah was described as a patient child who would attempt new tasks and cope with new situations. She was recorded as understanding “no” but tantrums were often and she was self-injurious. However she did not demand attention or get upset if attention was not given.

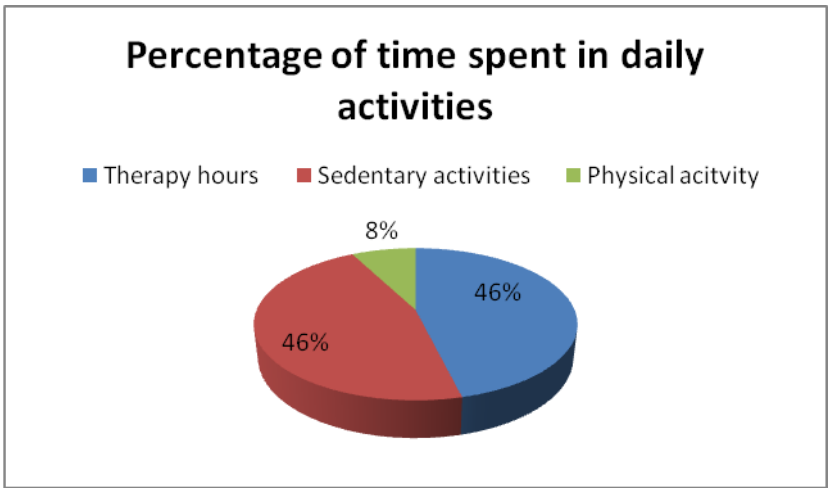

Figure 19 Percentage of the day that Sarah spends in various activities before implementation of intervention program

Post-test assessment

After the implementation of the intervention, the behaviour of Sarah improved in several areas. Both sleeping and eating patterns improved i.e., sleep routines improved and a variety of food was being tried and enjoyed. Sarah’s focus on a task or set of instructions noticeably improved.

Sitting with a straight back was recorded as unaided and Sarah was recorded as spending more time playing outside or swimming (see Figure 20). Other physical activities that Sarah has demonstrated voluntarily spending more time participating in, include jumping on the trampoline, running on the beach and making use of exercise balls and Mighty Muscle equipment.

Both fidgeting and unusual movements were observed less. She is still not able to swing herself but can use and hang from the monkey bars and enjoys playing on play apparatus. (Her parents built a comprehensive jungle gym in their garden and she really enjoys playing on it). Running, both style and endurance, improved drastically. Maladaptive behaviours were recorded less in the therapy sessions and at home.

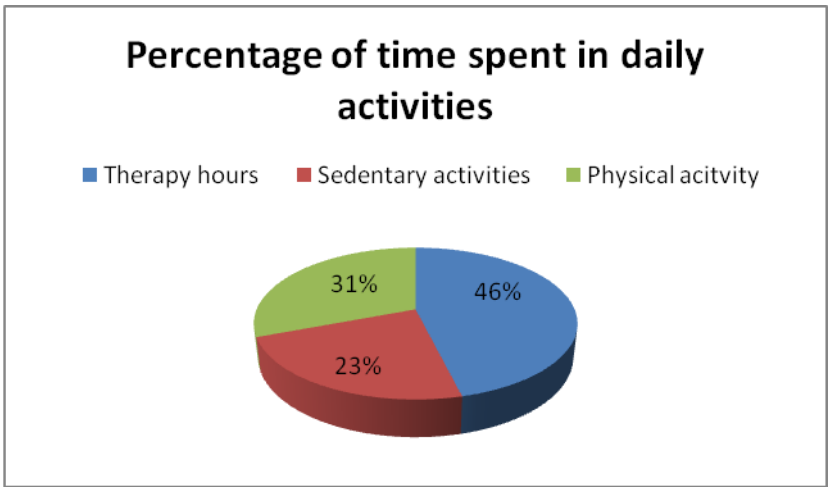

Figure 20 Percentage of the day that Sarah spends in various activities after implementation of intervention program

The implementation of the intervention program had a positive contribution to Sarah's daily living activities and social play. It is the reduction in the behaviours associated with autism that is the most evident.

Research Question three: Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

The individualised adapted physical activity program has clearly made positive changes to Sarah's behaviours, especially those behaviours associated with autism.

Journal and Session Sheets: Additional observations

Sarah thoroughly enjoyed the intervention sessions and would attempt to initiate intervention sessions on days when there wasn't one. She began to use the "Mighty Muscles" equipment spontaneously and appropriately outside of the intervention. She enjoyed the physical stimulation of the sessions and would ask for various exercises outside of session, e.g., stretching.

During the project Sarah learnt or mastered various skills through the program that were not recorded by the test instruments, but were recorded by the journal and session target sheets.

- Cardiovascular training: Skipping with a rope was not mastered but became more fluid and the concept was learnt. Stationery exercises like star jumps and hopping were mastered. The concept of catch was learnt.
- Strength training: Sarah exhibited improvement in muscular strength and muscle tone in all muscle groups. She was able to manipulate heavier weights and complete more straining tasks at the end of the intervention.
- Balance: Increased core strength helped with improved balance skills, both in static and dynamic balance exercises. When working on unstable environments, she was able to maintain her balance for much longer periods of time.
- Ball Skills: Catching, bouncing, throwing and aiming skills were very weak at the beginning of the intervention. However Sarah improved and mastered working with a big and medium ball and was attempting the same skills with a tennis ball at the completion of the project. Kicking and batting also were poor but the 20 week intervention resulted in her being able to have control and projection in both skills.
- Sport's skill: Both tennis and soccer were introduced and the foundation skills were learnt. Swimming was also included and basic diving and doggy paddle were mastered.

Discussion

Although Sarah's post-test assessment scores in the M-ABC are still indicative of a borderline motor impairment problem, the improvement from the baseline and pre-test assessment scores show there was an overall development in manual dexterity, ball skills and balance. Weekly practice, the continuous assessment of these motor skills, a program designed for the individual's needs and the overall improvement in strength from resistance training has resulted in this development and enhanced performance in these tasks. This confirms one of the benefits of resistance training which is the improvement of basic motor skills and the efficiency in the performance of these skills in motor tasks (Roberts, 2002).

Gross motor testing has shown that children with autism have difficulty with coordination, timing of movements and grading of leg and arm movements (Murray-Slutsky & Paris, 2000). This could explain the Sarah's results received in the dynamic balance tasks. This test Sarah found particularly difficult and only a slight improvement was observed.

Post-test assessments of Sarah in the BPFT show improvements across all motor proficiency skills. Her performance in the aerobic capacity test show an improved level of fitness as she was able to complete the test and was observed to be physically fitter and less affected by the test. This result confirms previous research that participating in a physical activity program will increase the level of fitness (O'Connor, French & Henderson, 2000, Yilmaz *et al.*, 2004). The test activities and the endurance exercises included tasks that Sarah enjoyed and participated in until fatigued. Ensuring that Sarah enjoyed her cardiovascular tasks resulted in longer periods of participation and independent selection of these tasks outside of the sessions (Reid & O'Connor, 2003).

A definite improvement in Sarah's general muscular strength and flexibility could be seen in the results in the BPFT, more specifically the arm hang, isometric push up, curl up and sit and reach test. There is limited research about the effects of a resistance training activity program on children with ASD. However it is clear from the results achieved in these assessments that an APA program can provide children with ASD an opportunity to improve muscular strength and flexibility which results in enhanced motor control, agility, coordination and power. Improvement in more complex skills confirm that physical activity programs can aid in teaching and developing foundational skills (Byrne & Hills, 2007).

After completion of the intervention program, Sarah was observed initiating games played in the Mighty Muscles sessions and was socially more interactive with the researcher. Her limited communication skills may be the result of poor social interaction with others that are unable to use Makaton. However Sarah is more aware of her body and objects around her and is more receptive when guided to communicate or socialise with others. Her improved social interaction

with the researcher confirms research that physical activity aids in development of socio-cognitive skills (Jasmin *et* al., 2009; Reid & O'Connor, 2003).

There has been a substantial decrease in self-stimulatory behaviours during activities as well as during free time. The research done on the effects of physical activities on children with ASD has been focused mainly on the reduction in these behaviours and confirms the results achieved (Elliot, Dobbin, Rose & Soper, 1994; Rosenthal-Malek & Mitchell, 1997). Sarah also has been documented being less aggressive and there are less self-injurious behaviours present. Similar results were observed by Allison, Basile and Mac Donald (1991).

Sarah thoroughly enjoyed the activities and the physical stimulation. The Mighty Muscles program for Sarah was targeted for her motor needs and functional goals (Baranek, 2002). With the correct use of prompts and reinforcement Sarah was able to feel confident in the activities and was able to access the reinforcers (Fox, 1991; Reid, O'Connor & Lloyd, 2003; Zhang & Griffin, 2007). As a result of the stimulation Sarah received from the intervention the hours spent in voluntary physical activity increased significantly (O'Connor, French & Henderson, 2000). Sarah's sedentary lifestyle confirms reports on the physical activity level and fitness of children with ASD (Pan & Frey, 2006; Pitetti, Rendoff, Grover, & Beets, 2007; Yilmaz *et al., 2004*). However the increased independent hours spent in physically tiring activities verify research that physical activity encourages voluntary participation (Fox, 1991) and results in children making healthy lifestyle choices (Byrne & Hills, 2007).

The positive contribution that this APA program had on Sarah's motor proficiency and behaviours demonstrate the benefit and importance of providing quality physical activity programs designed for the individual's specific needs and personally traits (Reid & Collier, 2002).

Recommendations

Recommendations for Sarah include daily participation in a structured, physical activity program. Sarah is spontaneously choosing to perform various tasks that she was introduced to during the intervention. However, her final scores in the

motor proficiency assessments still indicates that she exhibits motor impairments.

It is recommended that supervised exercises are executed with Sarah in order to improve her motor abilities. Continual development is necessary in the following areas, ball skills, balance, flexibility, sports and strength training with particular focus on upper body. Since Sarah's self-stimulatory behaviours and aggressive tendencies have reduced after the intervention program it is recommended that there is continual participation in a physical activity program. This will help maintain these behaviours and provide Sarah the stimulation she requires to manage these behaviours.

CHAPTER FIVE

RESULTS AND DISCUSSIONS

CASE STUDY TWO- David

Personal Background

David is a five year old boy living at home with his family. He was born in August 2003 and has been part of the ABA program for 3 years. His communication abilities have improved drastically over the past two years and he is now able to partake in a conversation and express his needs and views. He is able to describe his environment and tell stories. David has a fond affection for his family, especially his sister, and is very loving towards all of them.

David exhibits repetitive, stereotyped behaviour and play, e.g. he enjoys animals and finds it difficult to stay focused on a target that is not about this topic. He also self-stimulates and “hops” inappropriately/unnecessarily and sometimes it appears as though he cannot control this behaviour. David does not participate in any sport activities or physiotherapy and although he is moving continuously (he is unable to sit/stand still), he exhibits characteristics of low muscle tone. He plays appropriately with toys but does not participate in physical exercises spontaneously. There is a play structure in the garden at his home and David enjoys climbing on the frame and hanging on the monkey bars. He is unable to move across the monkey bars independently and is slow when climbing the structure.

David does not have any severe maladaptive behaviours but finds it difficult to listen to instructions the first time. David attends the Centre for Play and Learning twice a week and receives three home therapy sessions per week. The researcher participates in both the home and centre sessions and is involved in developing his program.

Motor Proficiency

Research question one**:** Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?

Movement Assessment Battery for Children (M-ABC)

David is tested on Age Band 1 as he was age five at the time of the study.

Manual Dexterity

The M-ABC battery starts with determining manual dexterity through three specific activities: posting coins, threading beads and completing a bicycle trail. The following results were recorded for David.

Posting coins (see Figure 21)

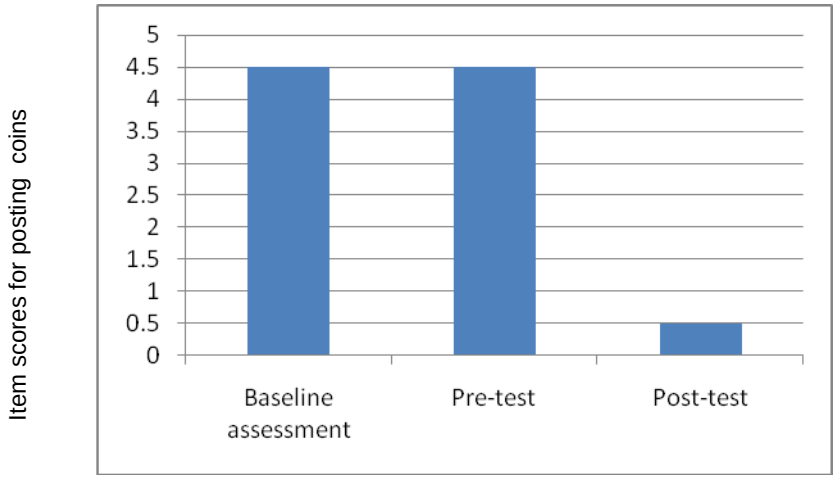

Figure 21 Manual dexterity: Posting coins for David

Baseline assessment

David's constant fidgeting and poor focus resulted in a lengthy time period in this test. He did not look at the slot while posting the coins and constantly tried to engage the researcher in a conversation about the coins. He has been exposed to posting tasks before but the novel stimuli of the coins caused much distraction. He thoroughly enjoyed the task and requested to play with the test equipment after the assessment was finished. This was not allowed.

Pre-test assessment

David was thrilled to be allowed to use the coin task and again this caused much distraction. During this assessment he would misalign coins with respect to the slot, especially with his non-preferred hand. His hand movements were jerky and he continued to converse about the coins throughout the assessment.

Post-test assessment

One of the targets of the intervention was to teach David the concept of “as fast as possible”. Mastering this target resulted in improved focus on the task during the final assessment. He still continued to discuss the coins during the task but his movements were more fluid and controlled and he was able to complete the task and maintain the conversation at the same time. There was still occasional fidgeting present.

Threading beads (see Figure 22)

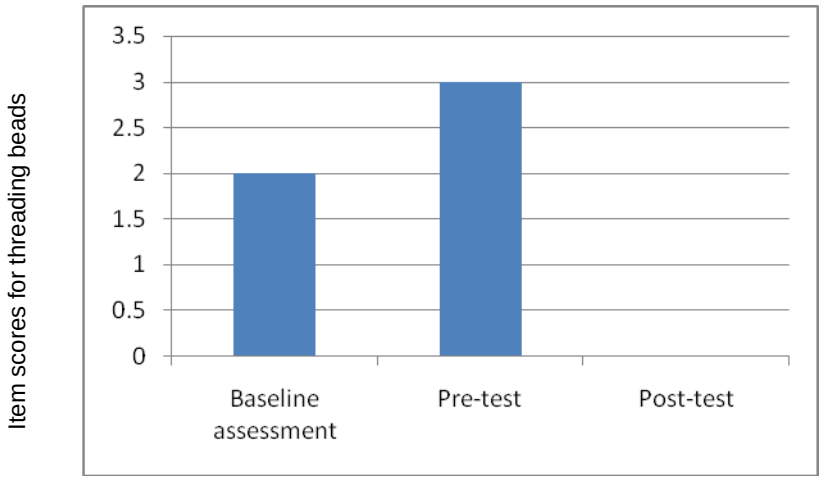

Figure 22 Manual dexterity: Threading beads for David

Baseline assessment

David has been exposed to this task before and was not distracted by the stimuli. His method for placing the beads on the lace exhibited many faults including holding the lace too far or too near to the tip, constantly changing hands during the trial and he would sometimes miss the hole with the tip of the lace. A lengthy solution that David resorted to was hanging the lace through the

bead. His constant moving affected the sturdiness and accuracy of his hand movements.

Pre-test assessment

David‘s poor method during this task resulted in a longer time period in the pre-test than in the baseline. Similar qualitative observations were seen as during the baseline assessment including disruptive fidgeting.

Post-test assessment

David appeared to be more in control of the beads and lace during the post-test and his understanding of the time component added to his improved focus. He performed the task correctly and did not hang the lace through the bead, but rather threaded it. No fidgeting was observed but he occasionally picked up the beads the wrong way round but he still managed to achieve an item score of zero.

Bicycle trail (see Figure 23)

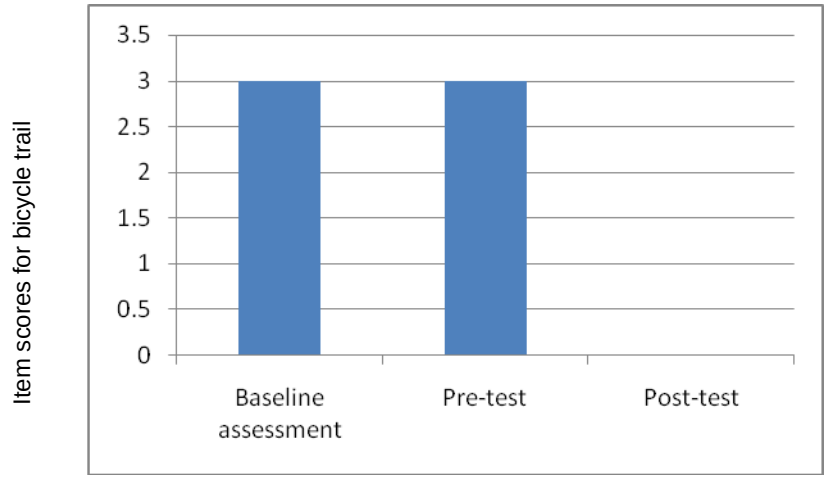

Figure 23 Manual dexterity: Bicycle trail for David

Baseline assessment

David enjoyed this task as well and really tried to perform it correctly but progressed in short jerky movements without holding the paper still and holding the pen with an immature grip. Errors in this task were also as a result of constant movement of his body and upper arms.

Pre-test assessment

In this trial, David did not look at the trail and completed the task too fast for an accurate execution. Movements observed in the baseline assessment were repeated in this trial and David achieved the same item score.

Post-test assessment

David's pen grip had improved as well as his movements during the trial. His movements were more fluid and a slower pace resulted in no errors. For this reason and the lack of observed fidgeting an item score of zero was achieved.

- **Summary of Manual Dexterity tests**

Table 8 Manual Dexterity: David

Baseline assessment	9.5
Pre-test assessment	10.5
Post-test assessment	0.5

There was an overall improvement in all three manual dexterity tests for David. During the intervention program the researcher taught David the concept of "as fast as possible" and this resulted in better focus for the first two trials. However this was not the sole reason for his improved scores. His method and control over his hand and arm movements were clearly visible. His drawing techniques and competency had improved in his art activities after the intervention, and this was noted by his parents. His ability to build structures with Lego had also improved in his therapy sessions.

Ball Skills

To determine ball skills proficiency two activities were used in this test: catching a bean bag and rolling a ball into a goal. The results obtained by David are as follows.

Catching bean bag (see Figure 24)

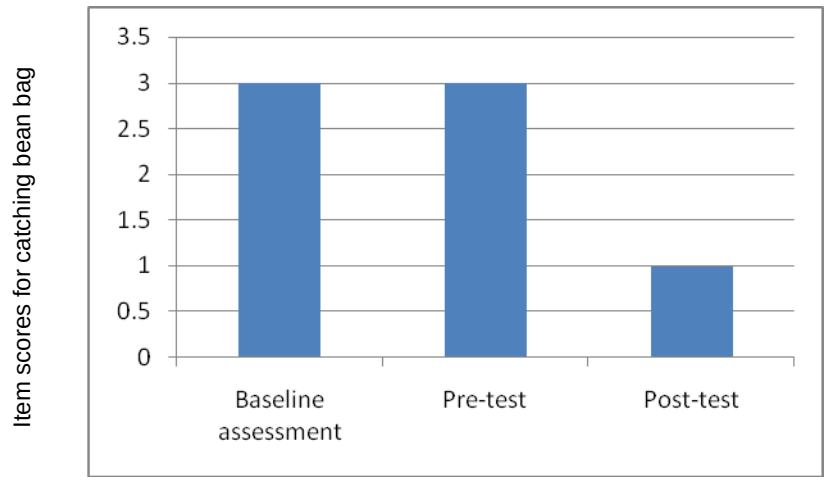

Figure 24 Ball skills: Catching bean bag for David

Baseline assessment

Qualitative observations for this trial exhibited many faults in David's execution of this task. He did not follow the trajectory of the bean bag with his eyes, he did not raise his arms symmetrically for catching and would hold out stiff fingers as the bean bag approached. His arms and hands were held wide apart and with fingers extended he would close his fingers too late when catching. David did not adjust to the height, direction or force of the throw and his movements lacked fluency. Self-stimulatory behaviours such as hopping and hand flapping interfered with focus and competency and he was only able to catch four out of the ten bean bags thrown to him.

Pre-test assessment

David's technique had not improved in this trial and he was only able to catch three bean bags successfully. Apart from similar observations seen in the baseline assessment David did not move until the bean bag struck his body. It appeared that the bean bag was too heavy for his fingers and hands to catch. Distracting behaviours were present again.

Post-test assessment

David was able to catch six out of the ten bean bags successfully and had improved significantly in this task. The reason for missing four bean bag

catches could be due to the poor tracking of the flight of the missed bean bags. There were no distracting self-stimulatory behaviours and David's movements were well-coordinated and he adjusted well to the height, direction and force of the throw. His arms and fingers were more receptive and accurate when catching the six bean bags and he successfully tracked the bean bags he caught. Improved tracking skills in the post-test aided David in successfully catching more of the bean bags than in prior assessments.

Rolling ball into goal (see Figure 25)

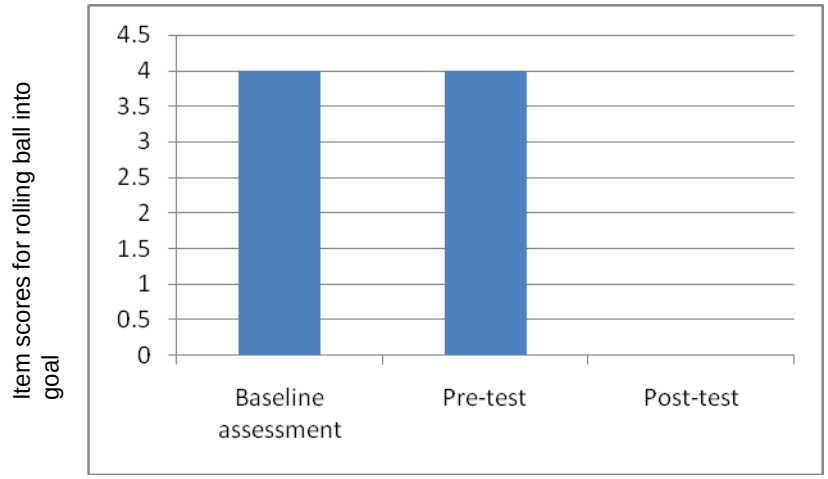

Figure 25 Ball skills: Rolling ball into goal for David

Baseline assessment

Although David is right hand dominant he primarily used his left hand in this trial. He was only able to roll two out of the ten balls into the goal. This task was a novel exercise for David and he thoroughly enjoyed the activity. However, he did not keep his eye on the target or use a pendular swing of the arm or a follow through. He would constantly change hands in the trial but would resort back to this left hand. He made poor adjustments to task requirements including poor control of direction and poor judgement of the force needed for the roll. The task required the child to kneel while rolling, but David constantly jumped up and lost focus and control of his posture.

Pre-test assessment

Again David used his non-dominant hand in this trial and although he frequently changed hands he rolled with his left hand. Similar observations to the baseline assessment were made including self- stimulatory hopping and jumping up. Overall his aiming skills were poor and the force required for the task was misjudged.

Post-test assessment

David was observed changing hands again in this trial however he used his right hand (dominant) for the rolling task. He received a zero item score as he successfully rolled nine out of ten balls through the goal. He was able to competently judge the force required for the task and used an accurate pendular swing of his arm with a follow through. He remained kneeling for the entire task and kept his eyes on the target.

- **Summary of Ball Skills test**

Table 9 Ball Skills: David

Baseline assessment	7
Pre-test assessment	7
Post-test assessment	1

Catching skills were one of the many targets focused on in the intervention program for David. The regular practice and overall development that David experienced in the intervention was clearly evident in the post-test assessment. A variety of catching stimuli was used including different sized balls and uncharacteristic objects such as bean bags, soft toys and fruit.

Once the researcher received David's results for the baseline and pre-test assessment aiming skills became a target included into his Mighty Muscle program (see Appendix G). Throughout the intervention activities included aiming at various goals. Not only rolling tasks were included but aiming at

stationary targets while standing and in motion were added as well. Once David showed improvement in these exercises the researcher progressed to moving targets while he was stationary and then moving targets while David was moving. Aiming targets were practiced not only with throwing but also with kicking and using a bat or golf club.

Balance

The determining of the balance levels as part of the movement assessment in the M-ABC test comprise of three sub-tests: one-leg balance, jumping over cord and walking heels raised. The following results were obtained by David.

One-leg balance (static) (see Figure 26)

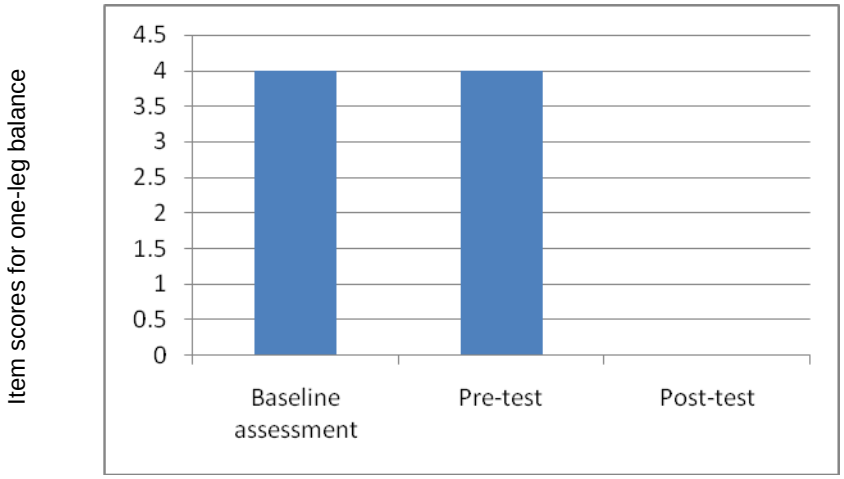

Figure 26 Balance (static): One-leg balance for David

Baseline assessment

Self-stimulatory behaviours disrupted this task negatively. David was observed hand flapping which resulted in him using exaggerated movements of his arms and trunk. This disrupted his balance on both his preferred (left) and non-preferred (right) leg. He did not hold his eyes and head steady and swayed wildly to maintain his balance.

Pre-test assessment

David was only able to hold his balance for one second longer on his preferred leg and received the same time (two seconds) for his non-preferred leg. This

was due to hand flapping, looking down at his feet, not holding his eyes and head steady, exaggerated arm movements and uncontrollable swaying. His ankles and legs appeared to tremble constantly.

Post-test assessment

A definite improvement in David's static balance could be seen in the post-test assessment. He was able to hold his balance for 15 seconds on his preferred leg and for 11 seconds on his non-preferred. He was able to efficiently control his arms and trunk and there was no swaying exhibited. He kept his eyes and head steady and only hand flapped very slightly for a very short period of time. There was no trembling in his lower limbs and he appeared stronger and more confident in the trial.

Jumping over cord (dynamic) (see Figure 27)

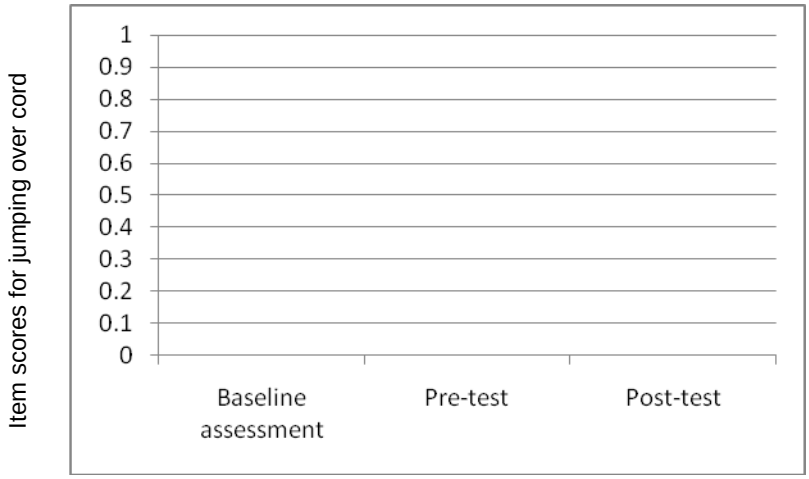

Figure 27 Balance (dynamic): Jumping over cord for David

David performed exceptionally well in this trial. He was able to pass the task on trial one and received a zero item score in the baseline, pre-test and post-test assessment. He was slightly nervous on the first trial but the practice sessions included in the test protocol helped David become more confident and sure of his skill.

David is constantly hopping with two feet and jumping in his free time and this has resulted in his competent performance in this trial. After the pre-test assessment it was noted that if David is required to hop over several cords in

succession his technique becomes more haphazard and uncontrollable. He was unable to jump over more than three cords in a row.

Walking heels raised (dynamic) (see Figure 28)

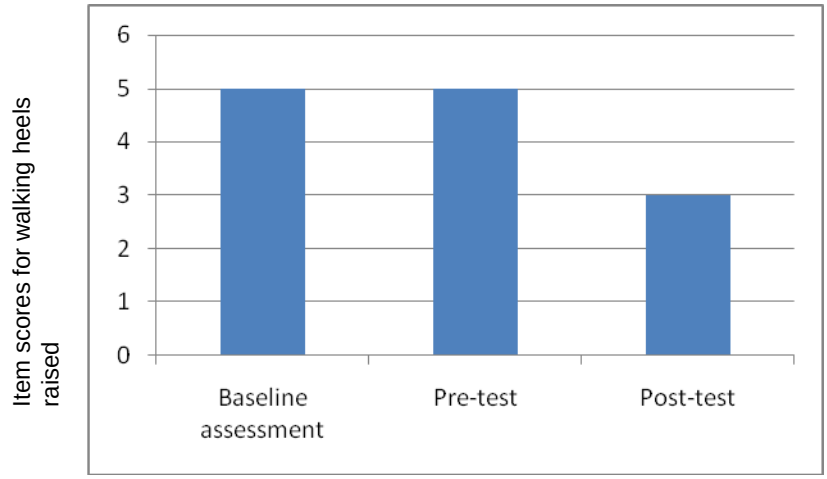

Figure 28 Balance (dynamic): Walking heels raised for David

Baseline assessment

David did not perform as successfully in this dynamic balance task as he did in the previous one. He was only able to walk four steps correctly as he did not compensate with his arms to maintain balance and completed the task too quickly for an accurate performance. Self-stimulatory behaviour, such as hand and arm flapping, was observed and he was very wobbly when placing his feet on the line. His legs and ankles battled to control the movement and keep his heels raised.

Pre-test assessment

David did not enjoy performing this task again and verbally expressed that he was unable to do it. The researcher encouraged him to try and he was only able to do three accurate steps. Similar weaknesses were seen in his legs and ankles and his arms and hand flapping did not aid in maintaining the balance.

Post-test assessment

Although David appeared more in control and performed the task slower his individual movements lacked smoothness and fluency. He was able to walk with

his heels raised for six steps and there were no hand flapping or trembling in the lower limbs.

- **Summary of Balance test**

Table 10 Balance Skills: David

Baseline assessment	9
Pre-test assessment	9
Post-test assessment	3

Not only did the researcher include balance in the intervention as a target for David but strengthening activities were added for his lower limbs including his ankles. He was taught skills to aid in maintaining his balance, such as holding arms still and keeping a steady gaze. Once static balance had improved on a stable environment, the researcher then placed David on more difficult surfaces to balance. These included exercise balls, balance boards and moving skateboards.

Dynamic balance targets were included in a majority of David's intervention programs and were applied to a number of different settings such as obstacle courses, walking on low walls, using roller-blades and jumping on different legs between stepping stones. Hopping over or onto various objects in sequence was practiced and games like hop-scotch were introduced. Balancing on one leg was tested by requiring David to catch a ball or move his arms to different positions. Strengthening exercises to his lower limb ensured that balance was not affected by a muscular weakness.

Research question one**:** Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?

The answer to Research Question one can be summarized through Table 11 indicating the overall results on the Motor Proficiency through the use of the M-ABC test for David:

Table 11 Baseline assessment, pre-test and post-test M-ABC Scores for David

	Baseline Assessment Scores	Pre-test Scores	Post-test Scores
Manual Dexterity	9.5	10.5	0.5
Ball Skills	7	7	1
Balance	9	9	3
Total Score:	25.5	26.5	4.5

It is clear from the results obtained by David in the post-test assessment that the individualised adapted physical activity program contributed positively to the performance of David's motor abilities.

General observations

David participated in the assessments with great enthusiasm and enjoyed the novel stimuli. However, his results in the baseline assessment and pre-test are reflective of his level of performance in foundation skills. His lower scores were due to him not using the correct method or not understanding the concepts of "as fast as possible". David fidgets continuously and this hindered his ability to focus on the task and maintain his control.

His total score for both baseline assessment and pre-test (see Table 11) fell below the 5th percentile, indicating that he experiences motor difficulties. However, his post-test total score show his drastic improvement after the intervention. His post-test assessment score place him in the 42nd percentile of children in his age group and is no longer suggestive of a motor problem.

The intervention program focused on developing and improving the weak foundation skills (see Appendix G - H). Once these were mastered, the level of skill of the task was increased. Decreased fidgeting and increased focus on the

task in the post-test also aided the improvement in scores, especially in manual dexterity.

Physical Fitness

Research Question two**:** Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?

Brockport Physical Fitness Test (BPFT)

The BPFT uses aerobic capacity, flexibility, muscular strength and endurance (a total of five test items) to indicate fitness levels of persons with disabilities. David's results on the BPFT are as follows.

Aerobic Capacity (see Figure 29)

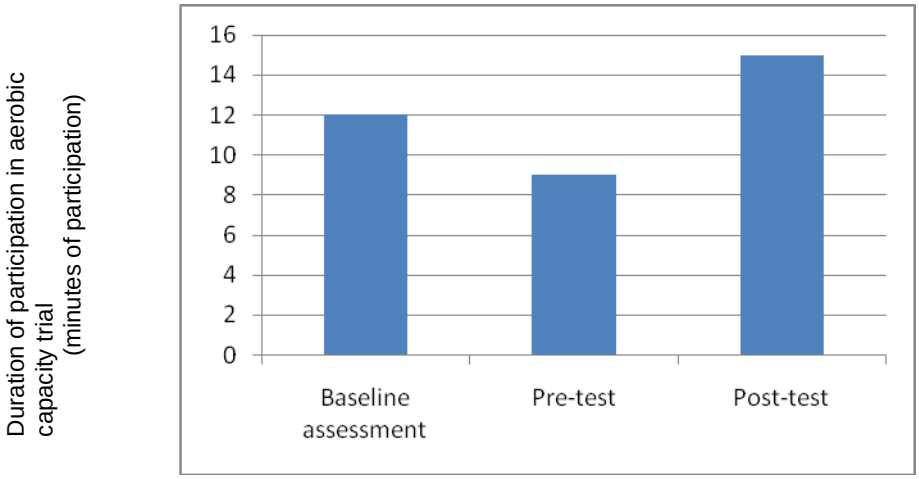

Figure 29 Aerobic capacity: Duration of physical participation for David

Baseline assessment

David thoroughly enjoyed the aerobic capacity test as this task required lots of running around and jumping on his trampoline. However after seven minutes signs of fatigue were exhibited. He appeared out of breath and struggled to keep up with the activities requested of him. Towards 12 minutes he frequently asked for rest breaks and would stop the activity for longer periods of time. This resulted in his target heart rate dropping below the required level for continued participation. After the test David was unusually still and physically exhausted.

Pre-test assessment

On the day of this test the weather forced the trial to be performed indoors. The researcher was unable to repeat the running activities that David enjoyed and had to resort to stationary cardiovascular exercises such as star jumps, skipping, hopping and jumping on his bed. Initially he enjoyed these activities but tired a lot faster than in the baseline assessment. After nine minutes David refused to continue and again displayed signs of fatigue, i.e. short, fast breaths, flushed cheeks, perspiration and the unusual lack of physically busy behaviour.

Post-test assessment

The post-test assessment was completed outside and included running activities which David enjoyed. He maintained the activities and his target heart rate zone for over 15 minutes and was eager to continue with the games after the test was completed. His breathing was more controlled and slower and afterwards he was observed jumping on the trampoline.

Even though David is very physically active during the day, the periods of activity are short and have a high intensity followed with a rest period. Therefore maintaining a high level of cardiovascular activity for a longer period of time was a struggle for David before the intervention was implemented.

The researcher designed fun ways for David to participate in longer cardiovascular activities such as running between trees in the park or playing catch. The time spent in each activity was recorded and over the intervention program the researcher would extend the amount of time spent in these activities.

Towards the end of the intervention David was observed to be more comfortable and competent in the activities. He required less encouragement and would continue past the specified time for the activity. His cardiovascular system appeared under less stress and he was able to manage his breathing more effectively. This was also observed in the post-test.

Muscular Strength and Endurance

Arm hang (see Figure 30)

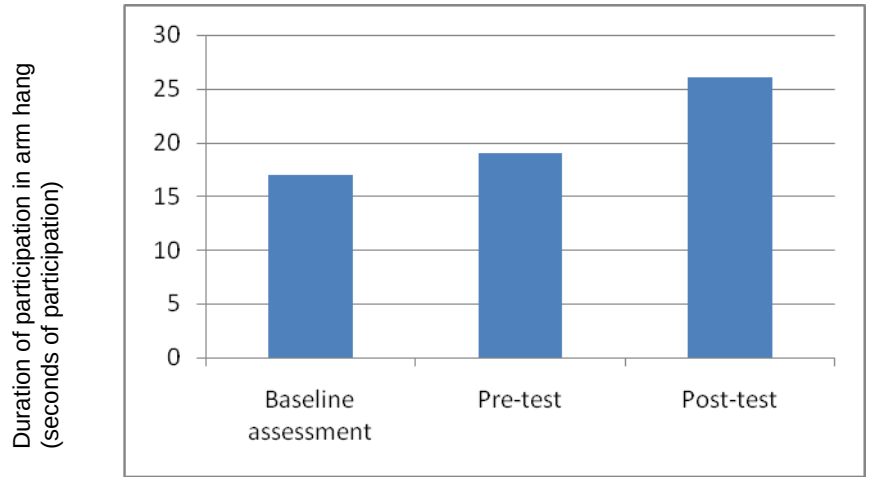

Figure 30 Arm hang: Duration of physical participation for David

Baseline assessment

David performed well in this test and was able to hang for a longer period than any of the other subjects tested. This is not a novel task as he hangs from the monkey bars in his garden at home. During free time the researcher observed David hanging from the bars but not for longer than seven seconds. In the test setting he was observed struggling to maintain his position on the bars after ten seconds.

Pre-test assessment

David was able to hang for an additional two seconds during the pre-test assessment but exhibited the same discomfort on the bars in the last eight seconds. He appeared restless and would wriggle his lower body and hold his breath.

Post-test assessment

Both time and capability improved in the post-test assessment. David appeared more comfortable and was observed breathing in a relaxed fashion. He was laughing and making conversation in the 26 seconds spent on the bar.

Although David was making use of the monkey bars prior to the intervention program he was unable to move across the bars independently. He required support and facilitation in moving from bar to bar. However, after the intervention program David was able to move across the entire bar without aid or instruction. His climbing abilities on the frame had improved and he was faster and more capable. Playing with his sister in this frame became a daily occurrence and he managed to scramble over the frame at the same speed as his sister.

Isometric push up (see Figure 31)

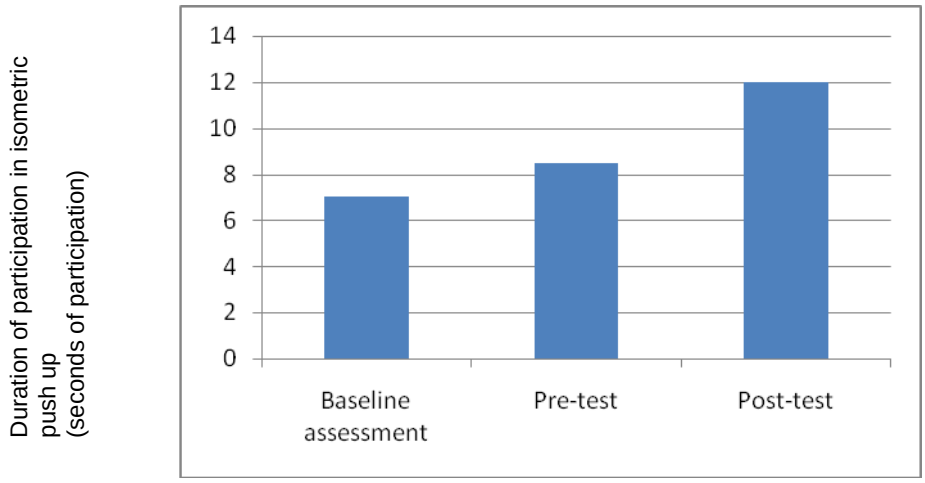

Figure 31 Isometric push up: Duration of physical participation for David

Baseline assessment

David did not enjoy this test and struggled to hold his position without raising his hips into the air. The researcher had to model the task in order for David to hold the position as long as possible. David's upper arms were observed to be shaking and he held his breath for the entire test.

Pre-test assessment

Due to familiarization of the test David was able to maintain his position for a slightly longer period. He still struggled to breathe and would shift on his hands and raise his hips. He ceased the position before the researcher did and complained that his arms were sore.

Post-test assessment

The researcher modelled the task again for David but during this assessment he continued to stay in the position once the researcher had stopped. He breathed comfortably during the task and asked the researcher to regain her push up position.

David struggled to put his body weight on his arms prior to the intervention and did not enjoy activities that required him to walk on his arms and would only do so for a short period of time. This target was included in David's Mighty Muscles program and games such as wheel-barrows and races on his hands and feet were included (see Appendix G).

After the intervention David was observed spending longer periods of time placing weight on his arms and an overall improvement in arm strength could be seen with activities like opening jars/containers, tug-of-war, lifting heavy objects and making use of heavier weights. There is also an enhanced control over the movement of his arms.

Curl up (see Figure 32)

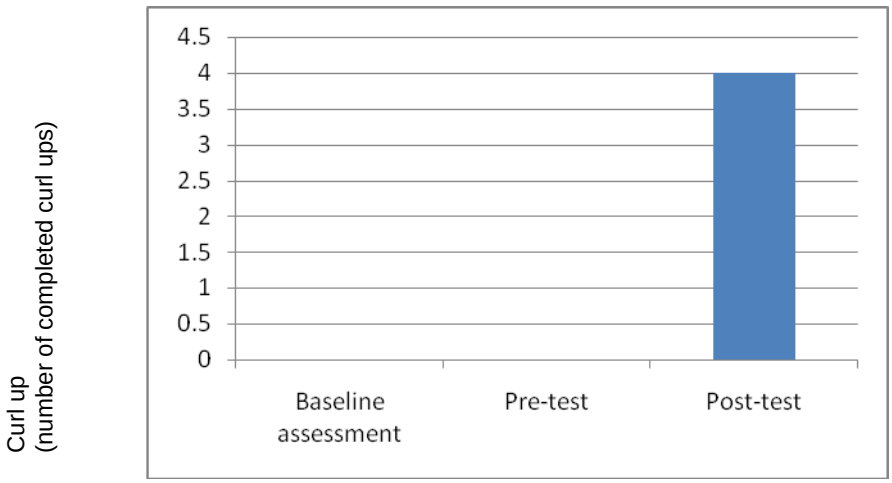

Figure 32 Curl up: Number of completed curl ups for David

Baseline and pre-test assessment

David was unable to perform this task according to the test specifications for both the baseline and pre-test assessments. When sitting up David requires the support and effort of both arms.

Post-test assessment

After the intervention program David was able to complete four full curl ups accurately and within the task time requirements. However on the fifth curl up he required the help of his arms. David's weak core strength was identified before the testing commenced. He battled to sit up from a supine position without the assistance of his arms or rolling over onto his stomach. He was also unable to lift his head and shoulders up whilst lying down. Core strength and abdominal muscle strength training were added to his intervention program and he was observed benefiting greatly from this.

After the intervention program David was able to sit up without arm assistance. Once in a supine position David was able to place a ball between his feet and raise his legs off the ground bringing the ball to his hands (he is able to perform numerous repetitions of this activity). Activities requiring core strength to aid in balance and performance have all improved including tasks on the exercise ball, skateboard and raising his legs to a point while hanging on the monkey bars.

Flexibility

Sit and Reach test (see Figure 33)

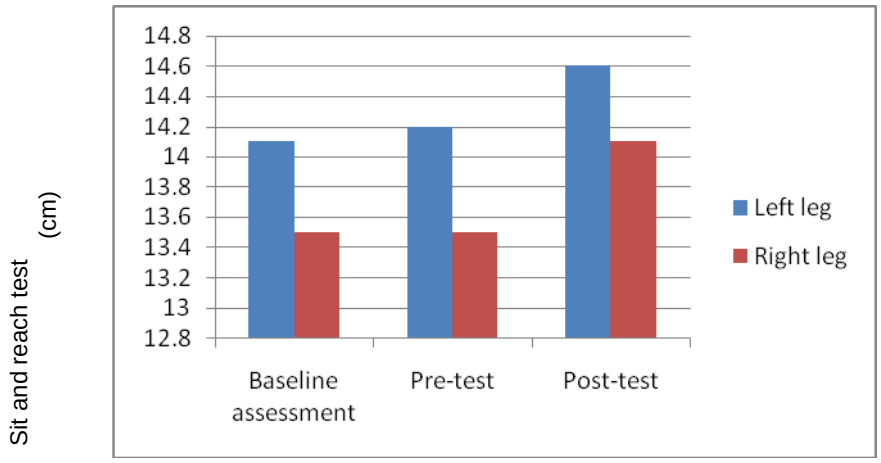

Figure 33 Sit and reach test for David

Baseline assessment

This task caused much discomfort for David and he was very quick to express this. He would say that it was “paining” him. More flexibility was observed in his left (preferred) leg.

Pre-test assessment

David was able to reach slightly further on the left leg in the second testing situation. However he still mentioned the discomfort and was unwilling to hold the position for a long period of time.

Post-test assessment

Range of flexibility had increased in both legs in the final testing and the range of difference between the legs was smaller. David did show symptoms of discomfort however he held the position for as long as the researcher required him to.

Each intervention session would begin and end with stretching exercises. In order to create a friendlier, approachable atmosphere to stretching, the researcher and David came up with fun names for the stretches. E.g., “butterfly legs” for the groin stretch and “giraffes drinking at the waterhole” for standing hamstring stretches. Specific goals to be achieved were continuously conveyed to him, i.e. “last week we could touch our ankles let’s see if we can touch the tops of our feet this time”.

Research Question two**:** Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?

The answer to Research Question two can be summarized through Table 12 indicating the overall results on Physical Fitness through the use of the BPFT test. The results for David are as following.

Table 12 Baseline assessment, pre-test and post-test Brockport Scores for David

Physical Fitness Component	Sub-test	Baseline Assessment Scores	Pre-test Scores	Post-test Scores
Aerobic Capacity	Aerobic capacity	Tired at 12 minutes	Tired at 9 minutes	Completed test
Muscular Strength and Endurance	Arm hang (seconds)	17	19	26
	Isometric push up (seconds)	7	8.5	12
	Curl up (number completed	0	0	4
Flexibility	Sit and Reach test (cm)	Left leg: 14.1 Right leg: 13.5	Left leg: 14.2 Right leg: 13.5	Left leg 14.6 Right leg: 14.1

After the completion of the intervention program the post-test assessment when compared to prior assessments, show the positive effect the individualised adapted physical activity program had on David's physical fitness. He is physically fitter, stronger and more flexible as a result of the intervention program.

General observations

David did not comprehend complex instructions that required him to maintain test positions, such as "hold still for as long as possible". However, through modelling the researcher was able to ensure that the subject ceased participation in the task due to fatigue, and not due to a lack of understanding.

As a physically busy child, the subject enjoyed the stimulation of the aerobic capacity test, however fatigued before the test was complete. The day of the pre-test was rainy and so the test had to be completed inside. The stationery cardiovascular exercises and lack of area to move may be the reason for the decrease in aerobic capacity between the baseline assessment and the pre-test (see Table 12). There was a slight improvement between the arm hang and push up scores of the baseline assessment and pre-test. Familiarization of test procedure could have caused this minor improvement. Between the pre- and post-test, there were improvements in all test scores. David was able to complete the aerobic capacity test and there were vast advancements in scores achieved post-intervention in the arm hang and curl up. Core strength was particularly weak prior to the intervention beginning. Exercises and tasks were designed to help strengthen this area for this participant. Improved strength in the participant's core had a positive impact in the post-test results.

Social Play, Daily Living Activities and Overall Behaviour

Research Question three: Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

Sherrill UVA-UPE Social Play Inventory

Results between baseline assessment and pre-test for the Social Play inventory were very similar.

Baseline and Pre-test assessments

- Unoccupied: If David was not involved in a task, it was noted that he would wander around aimlessly and demonstrate a range of repetitive movements, including hopping, jumping, falling down, frog-jumping and hand-flapping. All these activities fall under the category of self-stimulatory behaviours. Spontaneous play was rarely observed or appropriate. Object and person preference were sometimes demonstrated but not consistently.

- Solitary/Exploratory: David understood object permanence, he reacted to persons and explored toys. His reaction to stimuli was unpredictable, but visually he was more receptive. He did not explore body parts and did not show clear directed object and person preference.
- Parallel: David plays on playground apparatus and also plays independently with his own toys. However, his interactions and sometimes his awareness of others were minimal and even though he occasionally established play space near others, he would not join in on imitation games.
- Associative/Interactive: David needed constant assistance and prompting in order to initiate or play near others. He would talk to others but would not wait for a response and the interaction would only last for a brief period. Assistance was needed to ensure David listened to others and took turns appropriately. Sharing did not occur spontaneously.
- Cooperative: David was able to participate in a small group but needed constant facilitation in order to follow the rules and to remain focused. He was able to understand “stop” and “go” but concepts of group games needed regular explanations and he needed to be reminded to stay in the group.

Post-test assessment

After the intervention program, the following results were recorded on the inventory for David

- Unoccupied: All self-stimulatory behaviours decreased significantly and it was noticed predominantly by David’s parents. Unoccupied play had more direction, was more spontaneous and preference was shown for both object and person.
- Solitary/Exploratory: David’s response to all stimuli improved, noticeably were the improvements in response to auditory stimuli. Exploration of his environment became more determined, and again object and person preference became clearer. Being involved in a physical activity program stimulated his exploration of his body parts.

- Parallel: Awareness and interactions with peers increased significantly after the intervention. Improved confidence in physical activities saw David joining in on imitation games and obstacle courses more frequently.
- Associative/Interactive: Both initiation and maintenance of contact between David and others enhanced. Assistance was occasionally required to help clarify David's speech and intentions. Social skills, such as sharing, listening to peers, turn-taking and imitation were all observed occurring more spontaneously and more frequently. David engaged in imaginary play, however did need assistance in ensuring this play was understandable and appropriate. He approached peers more regularly but required prompting to use correct use of language and non-verbal cues, such as eye contact.
- Cooperative: David required facilitation in understanding game formations and goals after the intervention period however, his focus and comprehension of simple group rules and games improved. He was able to participate and sustain play for longer periods of time. Through the games played in the intervention, concepts like "boundary lines" and "catch" were learnt and this helped in the success of his performance with his peers. Focus to remain in the game still needed prompting but less frequently.

Behavioural profile

With regards to the behavioural profile and the daily living activities and behaviours of David, the baseline assessment and pre-test results were very similar again.

Baseline and pre-test assessment

Prior to intervention using the behavioural profile, David was described by his parents as a child with healthy and happy eating and sleeping patterns. He ate a variety of food at regular intervals with no difficulty and was not known to skip meals. He slept through the night and went to bed, sometimes by himself, at a regular time with no problems.

David was described as a child who was constantly moving and needed assistance to sit without fidgeting or to stand still for lengthy periods of time. He enjoyed a balance between playing outside and watching television. David was able to run and play on apparatus but was unable to swing himself or use monkey bars appropriately.

During therapy sessions on the floor, David required regular prompting to sit with legs crossed, as he preferred to sit with his legs either underneath him or with each leg bent next to him. He also battled to stand/sit still for long periods of time and would flop onto the ground or forward repeatedly. All these characteristics can be related to his low muscle tone. Walking was often replaced with “frog-hopping” or accompanied with hand-flapping and other unusual movements.

Inappropriate behaviour was documented when meeting new people, a response for his shyness. He understood “no” and was not observed as being aggressive or self-injurious. He did get frustrated with difficult tasks but would continue with assistance. Tantrums were rarely observed and he preferred to control certain aspects of his life and would get upset if this control was removed. He demanded attention but would wait patiently to receive it. He was described as being disruptive sometimes, especially in group situations.

Post-test assessment

Post-intervention results indicate that there was a large decrease in the appearance and frequency of self-stimulating behaviours (see Figure 34) and unusual movements seen during walking, especially in the disappearance of the frog-hopping. He fidgeted and flopped forward less and was able to sustain sitting/standing for longer periods of time. He was more comfortable sitting with legs crossed but occasionally was observed sitting unsuitably. Improved muscle tone as a result of strength training could explain this improved ability to control his body movements. David’s parents noted that this change in his behaviour was the most noticeable.

Confidence in using playground apparatus increased, and he was able to use the monkey bars independently. His ability to cope with a frustrating task

improved and it was observed that he was able to remain calm and focused much longer, especially in group settings. Shy, silly behaviour was still apparent with new people, but was easily corrected.

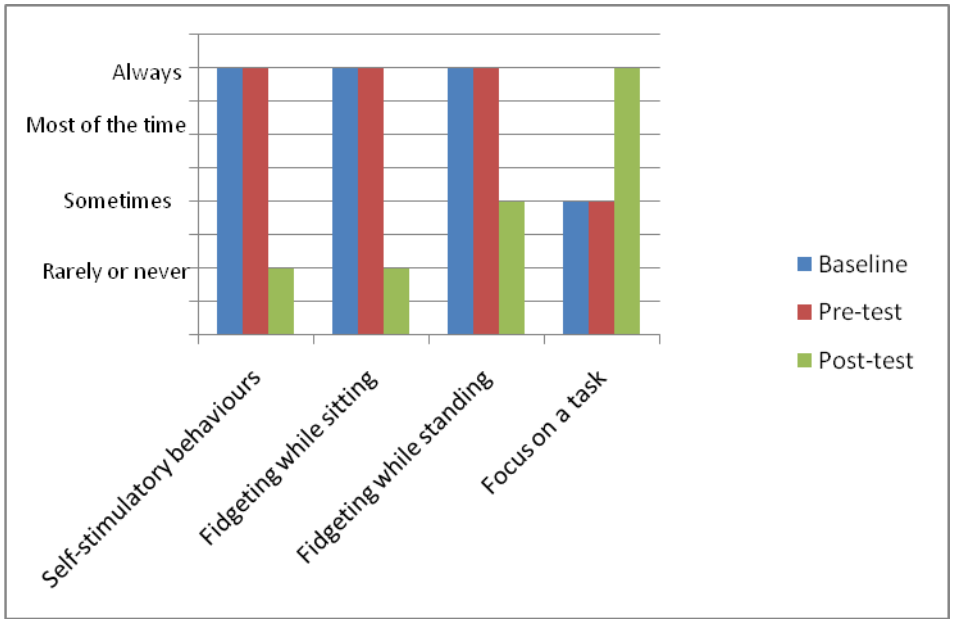

Figure 34 Significant results from behaviour profile for David

This component of the behavioural profile was displayed in Figure 34 to indicate the extent of improvement on David's behaviour, especially in school. Before the intervention program was implemented these behaviours were highlighted as problem areas for David. The results after the intervention program indicate the positive change in behaviour seen by David.

Research Question three: Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

With the many positive behaviour changes observed after the completion of the intervention prpositive effect on David's social play, daily living activities and behaviours associated with autism.

Journal and Session Sheets: Additional observations

The "Mighty Muscles" program soon became a firm favourite of David's activities during the day. He enjoyed the challenges of each task and really tried

hard to improve his skill in all areas. He would practice outside of the session and then be eager to show how he had improved. On a few occasions, he spontaneously invited his sister to join him in the session. He thoroughly enjoyed the interaction between them and developed a natural sense of competition. Notes from the journal and session data sheets show that he learnt and mastered a variety of new physical tasks.

- Cardiovascular training: Skipping, star jumps, hopping, skiing and galloping were all introduced and mastered during the intervention. Using a skipping rope was introduced but not mastered. Response time still needs to become quicker in order to master this skill.
- Strength training: David's strength was very weak at the beginning of the intervention program. In the beginning only David's own body weight was used for resistance in the strengthening activities. Towards the end of the intervention period David was independently using light weights and 2kg medicine balls. His core strength improved significantly and the condition of muscles had developed and become more defined.
- Balance: Weak muscles in his ankle and legs, resulted in David struggling initially with balance tasks. However, as his strength improved, so did his balance. At the end of the intervention program he was able to perform various activities that relied solely on balance skills and improved core strength saw him successfully balance on unstable environments.
- Ball Skills: David struggled with tracking an object in flight which resulted in poor performance in all ball skills. After improving this ability his performance in these skills developed positively. This included catching, throwing, batting, aiming, kicking and bouncing skills. At the end of the intervention, David had mastered all these skills using a big and medium ball and was focused on performing successfully with the use of a small ball.
- Sport's skill: Language became a barrier for this area, as concepts such as "goalie" were hard to explain, although David enjoyed learning new sports, such as tennis and soccer. His overall improved

physical performance made participation in these sports a lot easier. Concepts and foundation skills of the sports were learnt and after the intervention David was able to participate in the sport and understand basic rules.

Discussion

Results for the M-ABC show the positive contribution the APA program had on manual dexterity, balance and ball skills. Improved muscular strength and development of motor skills throughout the program have confirmed the research that lists the benefits of physical activity and the effect that this has on motor performance (Byrne & Hills, 2007; Cooper & Quatrano, 1999; O'Connor, French & Henderson, 2000).

David's improved performance in aerobic tasks show his stronger endurance stamina and fitness levels after participation in the intervention program. Similar improved fitness results to APA programs can be seen in Yilmaz *et al*. (2004), Lord (1997) and Pitetti *et al.* (2007).

Prior to the assessment David experienced difficulties with low muscle tone and poor midrange joint control. These difficulties have been identified in children with autism during gross motor testing (Murray-Slutsky & Paris, 2000). After the implementation of the intervention program not only did David's physical strength in his upper limbs, core and lower limbs improve but David now has better control over his movements, improved muscle tone and is more competent in activities that require physically strength. He is faster and is able to participate for longer durations. Resistance exercises using David's body weight and free weights show the documented benefits of resistance training (Haskell, 1987; Roberts, 2002).

David was not described as exhibiting a sedentary lifestyle, however after the intervention program he was observed using his free time more constructively and practicing or repeating activities done in his Mighty Muscles session. The program has encouraged David to perform appropriate actions and continue choosing healthy activities outside of the sessions. This is an important goal

when developing a physical activity routine (Fox, 1991; Byrne & Hills, 2007; Lord, 1997).

Socially David has become more spontaneously interactive and aware of others. He attempted to engage peers, including his sister, in tasks and tried to show them what he had learnt in Mighty Muscles sessions. David's focus on tasks, games and peers had improved and increased voluntary participation in games and obstacle courses has been observed. He appears to be more confident and happier in social and play settings (Pan & Frey, 2006; Jasmin *et al.*, 2009; Rosenthal-Malek & Mitchell, 1997).

David's self-stimulatory behaviour was reduced so drastically that his parents made several comments about the lack of "hopping" and inappropriate movements, less fidgeting while standing and sitting was also noted. This reduction confirms many reports on the effects of exercise on these behaviours (Rosenthal-Malek & Mitchell, 1997; Elliot, Dobbin, Rose and Soper, 1994).

Guidelines were followed to ensure that David received appropriate prompts (Davis, 1990; Zhang & Griffin, 2007), that the program was designed for his specific needs (Baranek, 2002; Berkeley *et al.,* 2001) and that David's enjoyment of the program was a primary goal (O'Connor, French and Henderson, 2000). David benefited tremendously from participating in this intervention program.

Recommendations

With the noted reduction in self-stimulatory behaviours by both the researcher and David's parents it is recommended that David continues to participate in a program that provides cardiovascular and strength training. His reduced fidgeting and ability to stand still for longer show the additional benefits of an activity program. Prior to the intervention David presented as a child with motor difficulties, according to the M-ABC. Supervised activities need to ensure weaker target areas are focused on in order to maintain the progress achieved. His program needs to focus on developing muscular strength and endurance as well as ball skills, sport skills and flexibility.

CHAPTER SIX

RESULTS AND DISCUSSIONS

CASE STUDY THREE- Paul

Personal Background

Paul is a right-handed five year old boy born in June 2003 and he has been involved in an ABA program since November 2005. The first year of his therapy consisted of home sessions where the researcher was involved in development and implementation of his home program. Targets in this program included language development, imitation skills, listening to instructions, play skills and matching targets.

When his ABA program started he had limited verbal repertoire and could not express his needs. His interests focused mainly on transport vehicles and edible reinforcements. Through his home program Paul learnt how to ask for objects he wanted and developed a confident set of imitation skills as well as appropriate play skills. As his progress continued he became confident in both speech and listening to instructions. He started to attend the Centre for Play and Learning for social skill development and further progression in his home targets. The researcher was involved in Paul's program at the centre.

Paul lives at home with his parents and older sister and he demonstrates a fond affection for all of them. His family is very supportive of his development and have been the driving force behind ensuring that Paul receives the therapy he needs. When Paul was five years old he started attending a neurotypical pre-primary school and received facilitation on certain days in order to teach the educators the methods required to assisting Paul. He developed favourite friends quickly and enjoyed his morning spent at the school.

Paul does exhibit certain stereotyped behaviour including a strong interest in cars and trains such as Thomas the tank engine and Lightning Macqueen. Self-stimulatory behaviours include continual pacing or running backwards and forwards. Paul spends the majority of his free time in these actions or jumps on

his trampoline for lengthy periods of time. He also jumps up and down and “jiggles” when he his excited or sees something he likes.

Paul understands the concept of “no” but is prone to tantrums if his needs are not met. He can be very demanding of attention and will pull the person’s face towards him when they are busy with a conversation. Part of his social skills program is to teach Paul to wait his turn to talk or to wait until the person he is talking to has finished. He often will shout over his sister or peer when it is their turn to talk and will try turn the attention of the adult onto himself.

In the last year Paul has started participating in a sports education program called Playball. This is his only extracurricular activity. His parents are both physically active and once Paul mastered the skill of riding his bike, the family would often take riding trips around public recreation facilities in their area.

Paul does not exhibit any self-injurious or aggressive behaviours and has a happy disposition. He enjoys running games and playing cars with peers. He attends three centre sessions and has three home sessions per week. On his free mornings he attend his pre-primary school. He also has one weekly speech session and through this and the work done in his ABA sessions he is able to use complex sentences, ask questions and express his wants and thoughts.

Motor Proficiency

Research question one**:** Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?

Movement Assessment Battery for Children (M-ABC)

At the age of five, Paul is tested in Age Band 1.

Manual Dexterity

The M-ABC battery starts with determining manual dexterity through three specific activities: posting coins, threading beads and completing a bicycle trail. The following results were recorded for Paul.

Posting coins (see Figure 35)

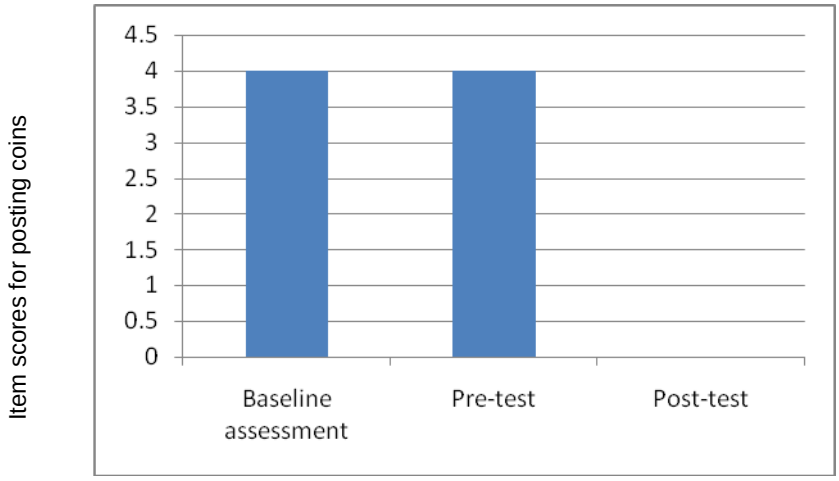

Figure 35 Manual dexterity: Posting coins for Paul

Baseline assessment

While using his preferred hand (right) Paul was able to pass the trial on the first attempt however, his time to completion was affected by several technique faults. These included not looking at the slot whilst inserting the coins, not using a pincer grip to pick up the coins, not holding the box steady with his supporting hand and misaligning the coins with respect to the slot.

With his non-preferred hand (left) he failed the first attempt on a procedural fault as he picked up two coins at the same time. One the second attempt he was able to understand the process more clearly and was able to pass with an item score of four. He demonstrated similar technique faults as his preferred hand and his movements were more jerky and unsure. The novel task of posting coins into the box created much distraction and excitement and self-stimulatory behaviours were seen.

Pre-test assessment

Paul's performance in the pre-test was identical to that of the baseline assessment including a pass on the first attempt with his right hand and a fail on the first attempt with this left hand. He also failed for exactly the same procedural fault of picking up two coins at the same time. He did however seem

less excited about the task during this assessment and was more focused on completing the task.

Post-test assessment

Both Paul's technique and time to completion improved significantly in the post-test assessment. He passed both trials first time and the only technique fault observed was that he did not use his supporting hand to hold the box steady. The concept of a timed test had been explained to Paul during his intervention program and he was focused on completing the task as quickly as possible. Paul's more fluid movements and better control of his hands and arms aided in his determined effort to finish quickly. He managed to receive an item score of zero.

Threading beads (see Figure 36)

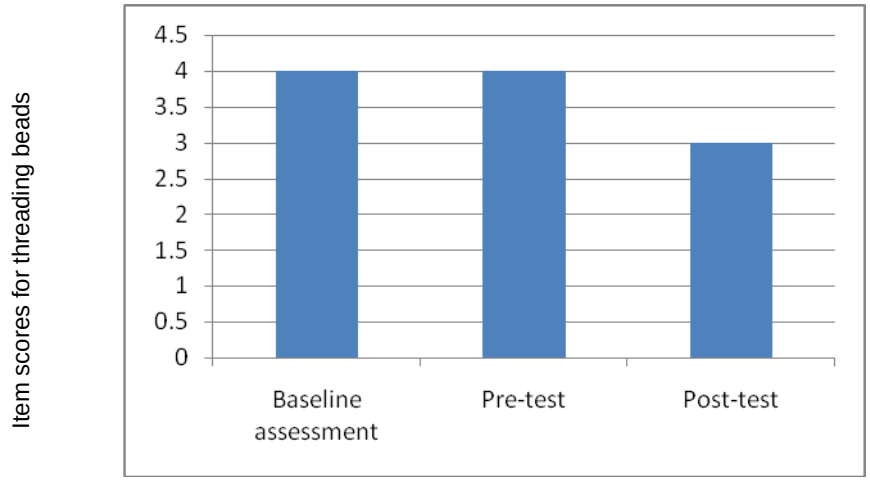

Figure 36 Manual dexterity: Threading beads for Paul

Baseline assessment

Threading beads was a target included in Paul's home therapy program and he does not enjoy this activity. Paul asked the researcher if they could do something else and was non-compliant when asked to sit at the table and do the task. With the right encouragement the researcher was able to persuade Paul to attempt the task. Similar to the first manual dexterity test Paul did not understand that he needed to complete the task as quickly as possible. However, as he did not favour the activity he did not waste time to finish it. The

overall completion time was a result of Paul holding the lace too far from the tip and sometimes missing the hole of the bead with the tip of the lace. He would change hands constantly during the trial and incessant fidgeting was observed.

Pre-test assessment

Paul was four seconds faster in this trial but this did not change his item score. He made the same mistakes as seen in the baseline assessment and there was fidgeting observed, but it occurred less during the trial.

Post-test assessment

Paul received an item score of three for the post-test assessment as he completed the task nine seconds faster than in the pre-test assessment. He did not change hands during the trial or fidget and his method for inserting the lace into the bead had improved, was more fluid and controlled.

Bicycle trail (see Figure 37)

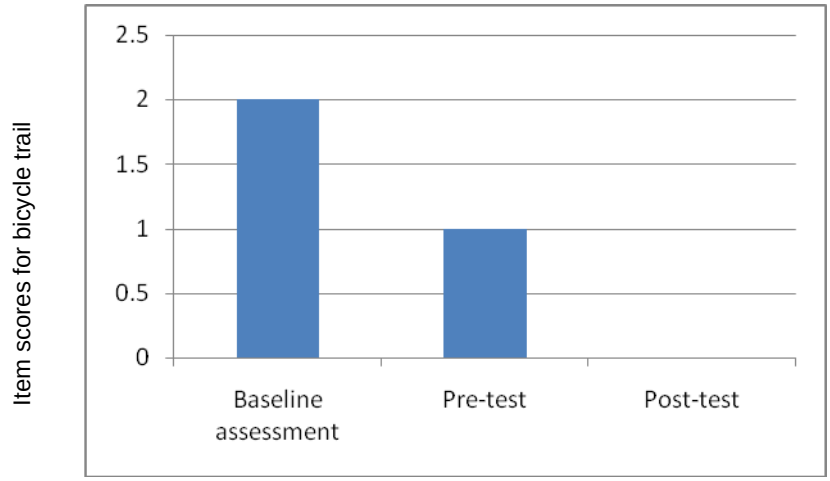

Figure 37 Manual dexterity: Bicycle trail for Paul

Baseline assessment

Paul enjoys drawing and has been exposed to many activities of a similar nature prior to this trial. He only performed three errors but was observed holding his pen with an immature pen grip and not holding the paper still.

Pre-test assessment

Paul progressed through this trial with short, jerky movements, an immature pen grip and without holding the paper. However he only made two errors on the pre-test assessment giving him an item score of one.

Post-test assessment

Over the course of the intervention, one of Paul's home therapy targets was to correct this immature pen grip. By the time of the post-test assessment he was holding his pen correctly and only performed one error, resulting in a zero item score.

- **Summary of Manual Dexterity tests**

Table 13 Manual Dexterity: Paul

Baseline assessment	10
Pre-test assessment	9
Post-test assessment	3

Paul's familiarization of the drawing task in the manual dexterity test helped him in performing so few errors. His ineffective ability to control his hands and arms were exhibited more clearly in the posting coins and threading beads tasks. However with his improvement in each task in the post-test assessment, the positive contribution the intervention program had on Paul's motor control of his hands and arms is evident. The positive contribution of the intervention program and strengthening exercises to his arms and hands helped with the posting and threading activities. However improvement in the drawing task could be associated with the correction in his pen grip achieved through his home program.

Ball Skills

Two activities used in this test to determine ball skills proficiency include: catching a bean bag and rolling a ball into a goal. The results obtained by Paul are as follows.

Catching bean bag (see Figure 38)

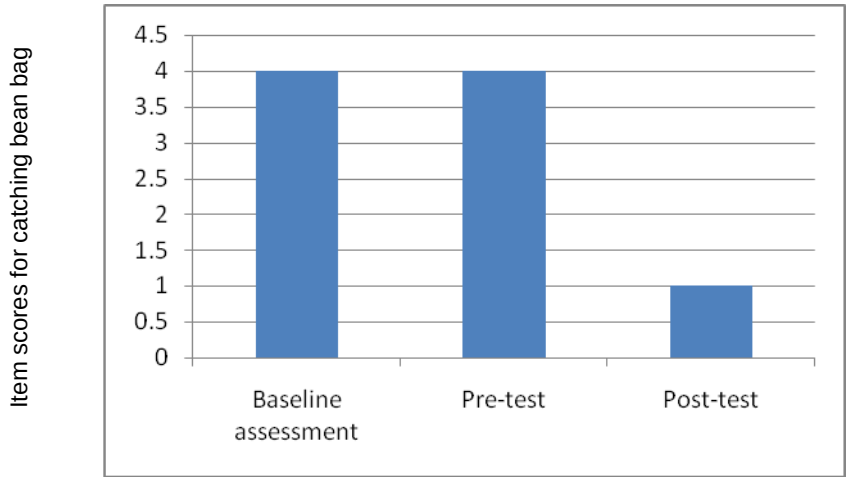

Figure 38 Ball skills: Catching bean bag for Paul

Baseline assessment

Paul was only able to catch two out of the possible ten bean bags in this trial. He was constantly jumping up and down and he did not follow the trajectory of the bean bag with his eyes. He held his hands out flat with stiff fingers and did not anticipate the impact of the bean bag. His fingers closed too late or too early when catching the bean bag and he did not adjust to the force of the throw.

Pre-test assessment

Paul exhibited the same catching style as during the baseline assessment and this resulted in him only catching two of the bean bags. He did not adjust to the direction or the height of the throw and self-stimulatory behaviours were present again. He dropped the bean bag repeatedly and it appeared as if the bean bag was too heavy for him to catch.

Post-test assessment

The item score achieved in this assessment was one as he was able to catch six of the bean bags. His technique had improved greatly and his arms and hands adjusted accordingly to the throw. His focus was better and no behaviours distracted him from the task.

Rolling ball into goal (see Figure 39)

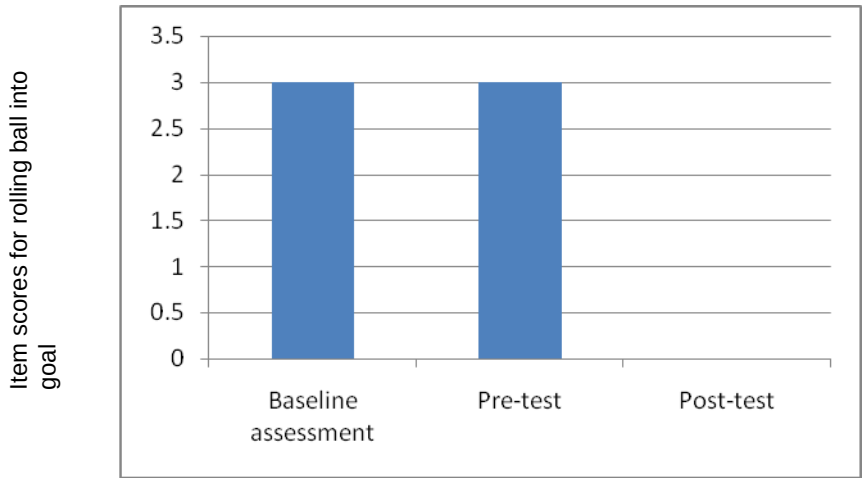

Figure 39 Ball skills: Rolling ball into goal for Paul

Baseline assessment

Paul used his preferred hand (right) for this task but was only able to roll three balls into the goal. He would use the back of his hand to push the ball and did not use a pendular swing of his arm or follow through with the rolling arm. He did not remain kneeling for the task and would jump up and jiggle.

Pre-test assessment

In this trial the researcher noted that Paul did not understood that this was a test and he only had limited chances of attempting the task correctly. He again used the back of his right hand and similar observations were made as during the baseline assessment, including disruptive behaviour. Paul again was only able to roll three balls into the goal.

Post-test assessment

Paul achieved a zero item score as he was able to roll seven balls through the goal. Correct use of his right hand was demonstrated and he remained kneeling for the entire task. He used a pendular swing and there was a clear follow through of the rolling arm.

- **Summary of Ball Skills test**

Table 14 Ball Skills: Paul

Baseline assessment	7
Pre-test assessment	7
Post-test assessment	1

Aiming, tracking, throwing and catching were all targets included into Paul's Mighty Muscle program (see Appendix I). During the intervention he worked with bean bags of various weights, small and big balls and novel objects such as toys and fruits. Kicking and batting were included into his ball skills program to ensure a more comprehensive development of ball skills. This stimulation as well as improved muscular strength in his arms and hands assisted in the better control and performance in the post-test assessment.

Balance

The determining of the balance levels as part of the movement assessment in the M-ABC test comprise of three sub-tests: one-leg balance, jumping over cord and walking heels raised. The following results were obtained by Paul.

One-leg balance (static) (see Figure 40)

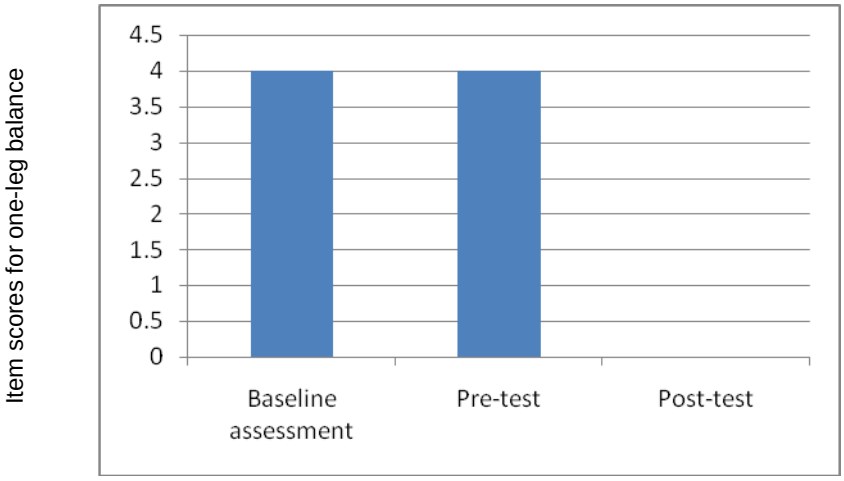

Figure 40 Balance (static): One-leg balance for Paul

Baseline assessment

In this task Paul was able to hold his balance for a longer period of time on his non-preferred leg, although it was only for four seconds. His "jiggling" and exaggerated movements of his arms and trunk disrupted his balance. He made no compensatory arm movements to help maintain his balance.

Pre-test assessment

Paul received an item score of four, identical to the baseline assessment. He was able to balance for a second longer on his preferred leg but balance time on his non-preferred leg decreased by one second. The same disruptive behaviours were seen as well as shaking in the lower leg and ankle. Paul did not hold his head and eyes steady and constantly looked at the floor or at his arms.

Post-test assessment

Balance improved significantly on both legs and Paul was able to achieve an item score of zero. He had better control of his arms, head and trunk and no "jiggling" was observed. He made the necessary compensatory arm movements to help his balance and his legs and ankles appeared stable.

Jumping over cord (dynamic) (see Figure 41)

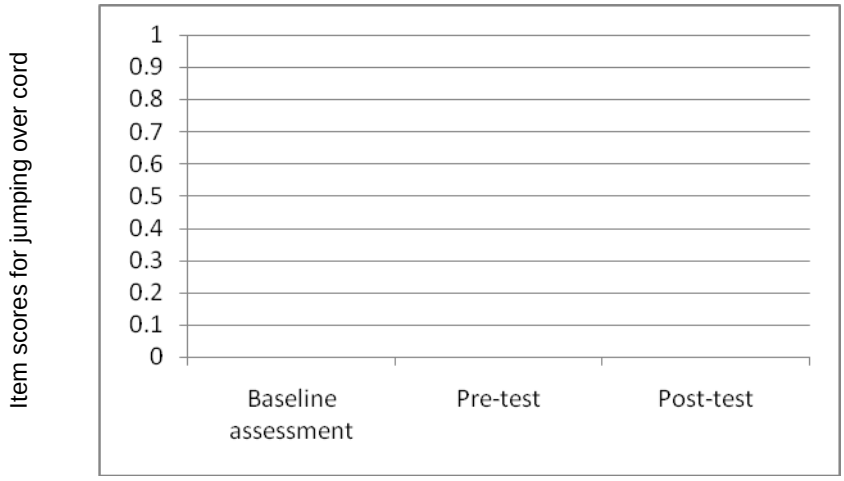

Figure 41 Balance (dynamic**):** Jumping over cord for Paul

A zero item score was achieved by Paul on the baseline, pre-test and post-test assessments. This was due to him passing the trial the first time on all assessments. He did very well and used accurate methods for jumping over the cord. He really enjoyed this task and the jumps and hops for all three assessments seemed to be very exciting. When made to jump over several obstacles in succession, Paul would fail on the second obstacle. He was unable to lift his legs high enough on the second jump and would inevitably knock the obstacle over He would also require a long preparatory phase before the second jump to coordinate his legs and arms.

Walking heels raised (dynamic) (see Figure 42)

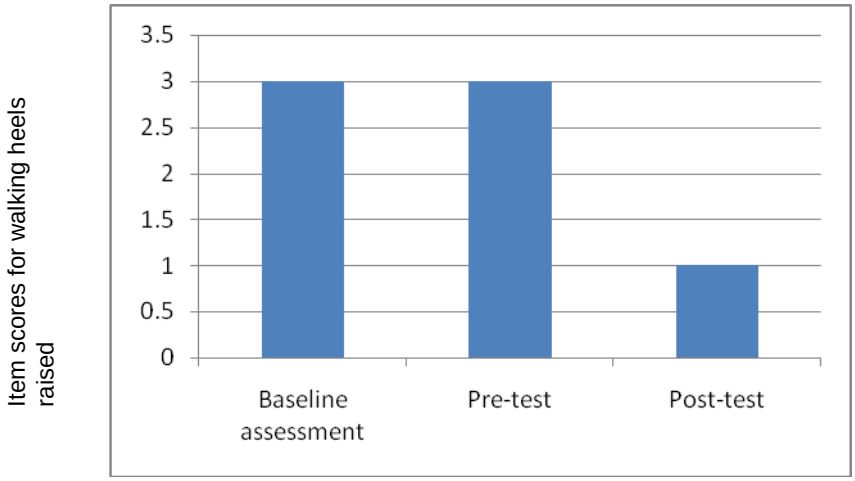

Figure 42 Balance (dynamic): Walking heels raised for Paul

Baseline assessment

Paul is able to walk on a line for over ten steps but when asked to raise his heels he was only able to perform six steps correctly. He did not use his arms to compensate the movement and help with balance, instead his exaggerated arm movements would disrupt his balance. He would go too fast for accuracy and would not look ahead. After six steps he placed his heels down resulting in the completion of the test.

Pre-test assessment

Paul performed seven accurate steps in this trial then he could not hold his heels up correctly. He appeared very wobbly when placing his feet on the line and similar disruptive behaviour was observed as seen in the baseline assessment.

Post-test assessment

Paul's lower limbs appeared more stable and stronger, holding his heels up for 11 steps. He was able to continue stepping with heels up however he stepped off the line. His arm movements aided him in his balance and his pace during the task was slower and more controlled.

- **Summary of Balance test**

Table 15 Balance Skills: Paul

Baseline assessment	7
Pre-test assessment	7
Post-test assessment	1

Balance was another major target in Paul's individualised Mighty Muscles sessions and was practiced at almost every session. Static balance on stable environments advanced to dynamic balance on unstable situations. Paul's improvements in his balance targets occurred concurrently to his advancements in his muscular strength in his lower limbs and core.

Research question one**:** Can an individualised adapted physical activity program contribute to the motor abilities of children with ASD?

The answer to Research Question one can be summarized through Table 16 indicating the overall results on the Motor Proficiency through the use of the M-ABC test for Paul:

Table 16 Baseline assessment, pre-test and post-test MABC Scores for Paul

	Baseline Assessment Scores	Pre-test Scores	Post-test Scores
Manual Dexterity	10	9	3
Ball Skills	7	7	1
Balance	7	7	1
Total Score:	24	23	5

With the overall improvement in Paul's motor abilities it is concluded that an individualised adapted physical activity program can contribute, in this case positively, to the motor abilities of a child with autism.

General observations

Paul was very compliant and tried extremely hard in all the trials of the M-ABC. Similarly with the other subjects, concepts such as "as quick as possible" were initially difficult for Paul to understand and the novel stimuli were a distracting factor. Paul's total scores for the baseline and pre-test assessments fall above the 5th percentile of children his age and is indicative of a motor problem (see Table 16). However his post-test assessment total score shows dramatic improvement in his performance in the M-ABC and his score of five places him in the 38th percentile of children his age. According to the M-ABC this score is not longer indicative of a motor problem.

After the baseline and pre-test assessment the researcher was able to identify certain problem areas and include these in the design and implementation of a Mighty Muscles program specific to Paul's target areas (see Appendix I - J). A significant improvement was seen in all three areas tested by the M-ABC and both Paul's understanding and performance in the tasks improved while previously disruptive behaviours had decreased.

Physical Fitness

Research Question two**:** Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?

Brockport Physical Fitness Test (BPFT)

The BPFT uses aerobic capacity, flexibility, muscular strength and endurance (a total of five test items) to indicate fitness levels of persons with disabilities. The results for Paul on the BPFT are as follows.

Aerobic Capacity (see Figure 43)

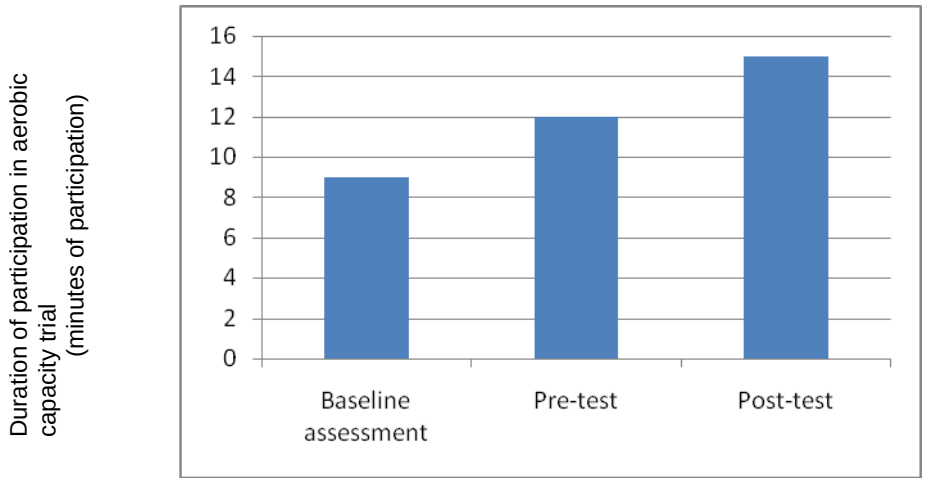

Figure 43 Aerobic capacity: Duration of physical participation for Paul

Baseline assessment

Paul enjoyed participating in the obstacle course and was able to maintain his target heart rate zone for eight minutes. In the ninth minute fatigue set in and his pace slowed down to a walk and his jumping ceased completely. His heart rate target zone dropped below the required level and the assessment ceased.

Paul was physically out of breath and requested water and then lay down on the floor.

Pre-test assessment

Paul was able to continue the assessment until the twelfth minute. He refused to continue after this and complained of not being able to breathe and being very hot. He did not want to continue with the other BPFT tests and required a lengthy rest period in which the researcher and Paul played with his trains quietly in his room. Once Paul didn't appear so flushed and his cardiovascular system had recovered the rest of the assessment continued.

Post-test assessment

Similar to the other subjects Paul completed the trial effortlessly with more energy and less stress to his cardiovascular system. He did not require water or a rest period afterwards and was eager to return to the obstacle course once all the BPFT tests had been administered. He was able to maintain his target heart rate zone as well as his running and jumping pace.

Even though Paul is accustomed to the activities in this assessment he does not maintain the pace or duration while participating in his free time. Before the intervention program was administered, once Paul was tired he would reduce his pace or refrain from jumping. After the intervention program the researcher noted that not only did Paul's endurance stamina increase but so did his recovery period. He only needed brief rest periods and then returned to the activity for longer periods of time and at a higher intensity.

Muscular Strength and Endurance

Arm hang (see Figure 44)

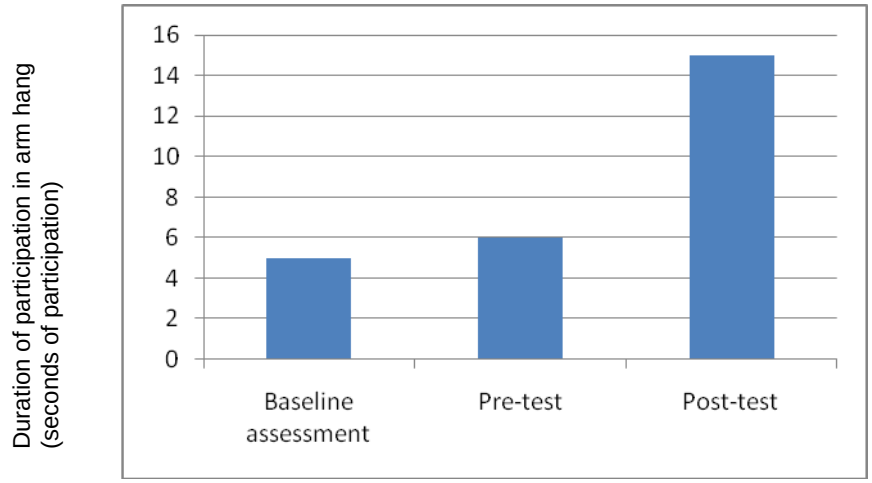

Figure 44 Arm hang: Duration of physical participation for Paul

Baseline assessment

Paul does not have a climbing frame or monkey bar structure at his house so this assessment was done at a nearby park. He was able to hang for five seconds and was observed shifting his body while hanging and grimacing. He expressed to the researcher that he was “too heavy” to hold on.

Pre-test assessment

At the time of this assessment Paul was not able to cross the monkey bars independently and when asked to hang from one of the bars was only able to do so for one second longer. He had a clearer understanding of test requirements and understood that he needed to hang on the bars as long as his arms could hold him.

Post-test assessment

Paul was able to hang from the bar for 15 seconds and appeared more comfortable and secure on the apparatus. Directly after the trial Paul returned to the structure and was observed hanging and crossing the monkey bars independently. He was also observed hanging from the bars and then lifting his legs to hook them over an adjacent bar.

Increased arm strength is clearly evident after the implementation of the intervention program. Not only was he able to double the time spent in the trial he has become more competent and skilled in tasks requiring him to use his arms to hang from.

During free time at the park Paul is observed choosing more activities that require this muscular strength and spends more time hanging on his arms without observable effort and strain.

Isometric push up (see Figure 45)

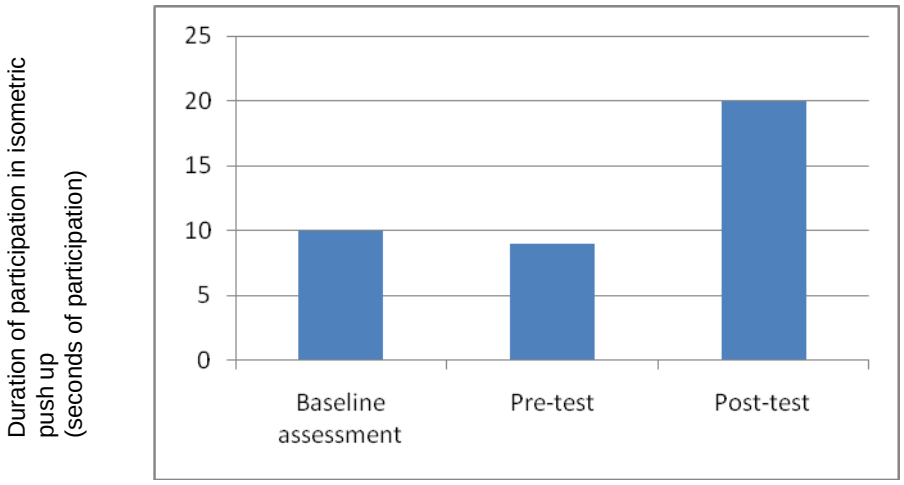

Figure 45 Isometric push up: Duration of physical participation for Paul

Baseline assessment

Paul was able to maintain the required position for ten seconds and the first six seconds Paul looked comfortable due to the fact he is accustomed to spending time on his hands. In the last four seconds he was observed struggling on his arms and shifting his hips. Both his wrists and arms were shaking and he complained of tired arms after the trial. He did not breathe easily during the trial and repeatedly asked if he could move around on his arms. The researcher explained that he needed to stay still and could put his knees down when his arms were tired.

Pre-test assessment

Paul reduced his time spent in the push up by one second and was observed with similar behaviours that indicated that he was uncomfortable and that the

task was an effort. After the trial was completed, Paul was not observed playing on his hands and feet and he was not interested in participating in his usual animal races.

Post-test assessment

Paul performed significantly well in the post-test assessment and was able to double the time spent in the push up. His body was still and his arms and wrists were stable. He did not ask to change positions and his breathing was relaxed.

Upper body strength was a target that was included in Paul's Mighty Muscle sessions. Prior to the intervention Paul was observed performing tasks that required him to support his body weight. This resulted in the researcher utilizing one kilogram weights with Paul at the start of the intervention. He took great pleasure using the weights and would often show the researcher or family "his muscles". By the end of the intervention Paul was using a two kilogram medicine ball very competently and was able to perform several half push ups (push ups done with the knees on the floor). Both post-test assessment in the hang test and the push up test show the improvement in his upper body strength. Paul's muscle tone has improved greatly on his arms and there is a visual difference in the tone and definition of the muscles in his arms, shoulders and back.

Curl up (see Figure 46)

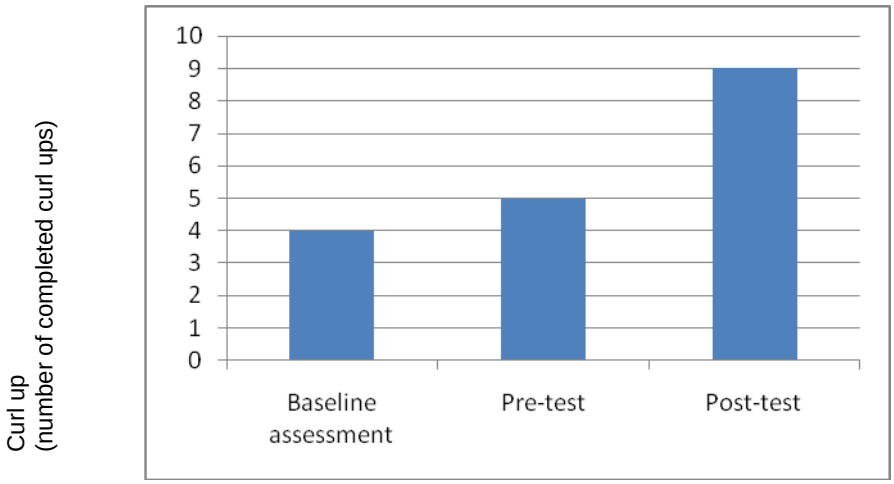

Figure 46 Curl up: Number of completed curl ups for Paul

Baseline assessment

Paul was the only of the three participants able to perform a correct curl up in the first assessment. After four curl ups he needed the assistance of his arms to sit up and complained of a stiff neck.

Pre-test assessment

Paul performed an additional curl up in the pre-test assessment compared to the baseline assessment. He was not breathing easily and resorted to using momentum on the sixth curl ups. He did not perform this in the required time and the test was completed. The effort required to complete this trial was evident in his facial expressions.

Post-test assessment

Paul was able to perform nine accurate curl ups with great ease and natural breathing. On the tenth curl up he rested briefly and continued with another four curl ups. However the rest period resulted in the tenth curl up taking longer than the test allowed.

Core and abdominal strength exercises were performed in each intervention session. The researcher used Paul's body weight, additional free weights and an exercise ball to develop this motor fitness component. His agility and speed in exercises requiring core strength improved greatly throughout the intervention program. Paul was able to sit up using his abdominals only and could maintain his balance while seated on an exercise ball without the assistance of his arms or legs.

Flexibility

Sit and Reach test (see Figure 47)

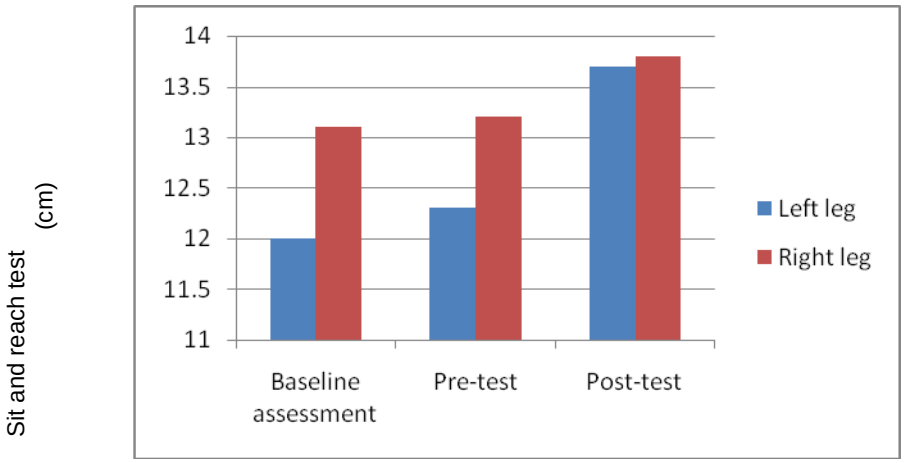

Figure 47 Sit and reach test for Paul

Baseline assessment

In this trial Paul demonstrated better flexibility in his right leg than in his left leg. Holding the position for the measurement to be taken caused discomfort and he expressed the tight feeling he had behind his knees. He was unable to touch his toes or his shins at the time of this assessment.

Pre-test assessment

Paul received slightly better scores in both legs for the pre-test assessment. The tight feeling was still present and his facial expressions confirmed his distress.

Post-test assessment

Paul achieved an improvement in both legs but a more noticeable change in his left leg flexibility. The range of difference between both legs had almost disappeared and he was able to perform this task with more comfort and without any aching in his legs.

All intervention sessions started and finished with full body stretching and the naming of stretches made the activities more enjoyable and distracted from the discomfort. By the end of the intervention program Paul was able to touch the

top of his feet in both a standing and sitting position and flexibility in his back had improved as well.

Research Question two**:** Can an individualised adapted physical activity program contribute to the physical fitness of children with ASD?

The answer to Research Question two can be summarized through Table 17 indicating the overall results on Physical Fitness through the use of the BPFT test. The results for Paul are as following (see Table 17)

The improvement in Paul's physical fitness levels in the post-test assessment demonstrates the very important contribution of the individualised adapted physical activity program.

Table 17 Baseline assessment, pre-test and post-test Brockport Scores for Paul

Physical Fitness Component	Sub-test	Baseline Assessment Scores	Pre-test Scores	Post-test Scores
Aerobic Capacity	Aerobic capacity	Tired at 9 minutes	Tired at 12 minutes	Completed test
Muscular Strength and Endurance	Arm hang (seconds)	5	6	15
	Isometric push up (seconds)	10	9	20
	Curl up (number completed)	4	5	9
Flexibility	Sit and Reach test (cm)	Left leg: 12.0 Right leg: 13.1	Left leg: 12.3 Right leg: 13.2	Left leg 13.7 Right leg: 13.8

General observations

Paul is normally a very busy child and in his free time is found running backwards and forwards in his garden or jumping on his trampoline. This behaviour is not done for the physical benefits of exercise but rather as a repetitive behaviour when he is not involved in an activity. This behaviour was utilised as part of the test for the aerobic capacity trial in the BPFT. An obstacle course was constructed with running stations which fed into jumping on the trampoline. Paul took much pleasure in this activity. However was only able to complete the test in the post-test assessment.

Initially Paul had difficulty with understanding the oral instructions of each task and required demonstrations from the researcher. “Holding the positions as long as physically possible” was a concept that needed further explanation for Paul. The same method of parallel participation by the researcher ensured that Paul remained in the trial as long as he was physically able.

Paul does experience low muscle tone and this can be seen if asked to remain seated for a long period of time or to stand still. Prior to the intervention when Paul was seated cross legged he would raise his right leg and rest his body on the bent leg or would slouch forward. When standing for a long period Paul would fidget or move around. Focus on standing still would have to be brought to Paul’s attention and a target would have to be given to him in order for him to comply.

Paul does spend free time playing on an exercise ball and he enjoys imitating animals and running around on hands and feet. This physical type of activity resulted in his higher baseline and pre-test assessment scores for the isometric push up and curl ups. However the intervention program developed this muscular strength as can be seen in the post-test assessment.

Social Play, Daily Living Activities and Overall Behaviour

Research Question three: Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

Sherrill UVA-UPE Social Play Inventory

Results between baseline assessment and pre-test for the Social Play inventory were very similar.

Baseline and Pre-test assessments for Paul

- Unoccupied: During unoccupied play Paul rarely pounded, shook or mouthed objects without purpose. He was observed wandering around aimlessly and self-stimulated as well as made stereotyped or repetitive movements such as continual bouncing on the trampoline or jiggling. He would occasionally show spontaneous play and did exhibit a preference for an object or a person.
- Solitary/Exploratory: Paul understood object permanence and would sometimes explore body parts and objects or toys. He exhibited object and person preference and would occasionally react to a stimuli, person or object in his environment. Depending on the stimuli, Paul would either walk away or explore the situation.
- Parallel: Paul would play independently with his own things and would occasionally establish a play space near another child depending on the space confinements. If Paul was able to remove the toy and play alone he would. Awareness of another child was exhibited but there was no interaction and he would usually remove himself from the situation if it was not a preferred child. Paul would play on playground apparatus but without interacting with others and would only participate in an imitation game if prompted. He would join in on an obstacle course but not for peer interaction but rather for the physical stimulation.

- Associative/Interactive: Paul had developed firm favourites in certain peers and this would affect his interaction greatly. He would talk to peers that he favoured and initiate contact but would not share or listen appropriately. Turn taking usually needed supervised guidance as did imitating and passing of toys or objects. Paul enjoyed playing make-believe but the game was done on his terms and if the peer would want to change the game, Paul would continue with his own interpretation or demand the peer to conform. For peers that were novel or were not preferred there was rarely spontaneous interaction or conversation. The researcher noted that this may be due to poor speech skills or lack of confidence. Paul needed prompting to listen when others would request something or when he had to share with or retrieve objects for peers.
- Cooperative: Paul would participate in a small group of preferred peers, but would need prompting to remain in the play situation and to take turns directing the order of play. He wanted to be in control of the game and would not listen to others' requests. Paul was able to understand simple game rules and concepts like "stop" and "go" but would need prompting from a facilitator to remain in the game or abide by the rules. Boundary lines, safety zones, bases and complex game formations were difficult for Paul to understand. Games that required certain roles were accessible for Paul but if he preferred a certain role he rarely would switch unprompted to the non-preferred role, e.g., he would only want to be the lion in a chase game as opposed to being the rabbit.

Post-test assessment

After the intervention program, the following results were achieved on the inventory for Paul

- Unoccupied: A reduction in Paul's stereotyped and self-stimulatory behaviours was noted by both the researcher and Paul's parents His unoccupied play is more spontaneous and directed with response to the environment. He was not observed wandering about aimlessly.

- Solitary/Exploratory: Paul was much more responsive after the intervention program with more reactions to stimuli and he exhibited more exploratory behaviour as opposed to avoidant or occasional reactions.
- Parallel: Paul has been observed establishing play spaces near others accompanied with spontaneous interactions, regardless of the peer. He would follow them to different areas and would spontaneously join in on imitation games or when a group were imitating each other. If a group of peers were reacting to an insect or an instruction he would join in.
- Associative/Interactive: Before the interaction Paul appeared to have several favourites and would reserve interactions for them. However, during the post-test assessment the researcher observed Paul initiating and maintaining interactions with a wide variety of peers. He would imitate others and bring joint attention to toys or objects that a group of peers were playing with, e.g. in the sand pit Paul would spontaneously share with others his constructions and ask them to join him in his ventures. He only needed occasional prompts to share and was more responsive to instructions from peers. It was noticed that he would ask questions or invited peers to join him in a game of make believe, or join him on the playground apparatus. Paul also brought toys or objects to peers to entice them into a game with him, e.g., he would bring an additional toy car to a friend and say “Let’s race”.
- Cooperative: Paul would participate in small groups for longer periods of time without prompts to sustain participation in the game. The make-up of peers in the group was not selective to preferred peers. He followed group instructions and only occasionally needed prompts reminding him to take turns sharing different roles in the games. Complex game formations still needed facilitation and explanation but his understanding and effort in attempting the games had improved.

Behavioural profile

With regards to the behavioural profile and the daily living activities the baseline assessment and pre-test results were very similar again.

Baseline and pre-test assessment

Paul was described by his parents as a child who would eat happily at regular intervals but would occasionally skip meals or need assistance in eating a certain amount. He would eat a selected variety of food and would rarely try novel foods. Paul's sleeping patterns are excellent and he never battles to fall asleep or wake up in the morning. He would occasionally take naps during the day.

Paul can be described as a child who is constantly on the move and he needs help to sit still without fidgeting. He often chooses to play outside in the garden but this results in him running around the garden without purpose or jumping on the trampoline for extended time periods. He enjoys watching television but is selective in what he watches.

Paul sits cross legged comfortably and rarely needs to be told to cross his legs. However, he does hunch over while sitting and needs prompting to sit with a straight back. If he is made to sit for a lengthy period of time he will sometimes pull up one leg and rest his upper body on that bent leg. This is an indication of low muscle tone. Standing results in fidgeting and a desire to move to different places. While in motion between places Paul enjoys to run or hop. He is comfortable in his running style and enjoys playing on slides and round-abouts. He is not prone to playing on climbing equipment and cannot use monkey bars independently. He is not able to swing himself independently.

At school it was noted that Paul battles to remain focused on verbal discussions at mat time. He will be sitting quietly but not absorbing or participating in the discussions. When asked what everyone is talking about Paul struggles to remember. He is able to maintain focus in art activities and construction.

Paul is not a shy child and can cope with new people and situations well. Novel, difficult tasks result in slight frustration but he is quick to ask for help. Paul understands "no" and sometimes throws tantrums to get what he wants. He is not self-injurious or destructive to his environment. He battles to be patient especially if he wants something and if trying to attain someone's attention. He will pull the individual's face towards his regardless if that person is engaged in

a conversation with someone else. One of his home program targets is to wait for his turn to talk and gain someone's attention appropriately. He can be disruptive to an existing conversation and does get upset if the attention is not gained quickly.

Paul's parents have noted that he performs "jiggling" actions and have put this down to excitement. When Paul is engaged in a conversation he enjoys or if he sees something he likes he will jiggle and jump up and down. This can be disruptive if you are trying to have a conversation with him or requesting an answer to a question.

Post-test assessment

Significant changes to Paul's daily living skills and behaviours include the reduction and disappearance of self-stimulatory behaviours including his excited "jiggle" (see Figure 48). His free time has more purpose and direction and he is not observed running around aimlessly. He exhibits more patience and has developed skills to obtain attention correctly e.g. tapping someone on their shoulder and waiting for them to pay him attention. There have been less tantrums observed and he appears calmer and more understanding.

Paul can sit and stand for longer periods of time without fidgeting after the intervention program. During his free time he chooses activities that are not always moving around and he has been observed playing quietly and calmly in his room. He is able to sit for a longer period of time with a straight back and does not require reminding to sit up straight. He does not need a supporting leg to rest one and moves from one area to another in a clam manner without running and hopping. It is obvious that he presently has more control.

Paul is participating in and absorbing more of the verbal discussions at school. He is able to focus on the lesson and is interested in telling the class relevant information about himself or the topic. His focus in home therapy sessions has improved greatly. He is more responsive and pays attention for longer periods of time. Working with Paul has become easier and he is more compliant and interactive because of improved focus. With peers he is more interested and

interactive and has been observed initiating conversations about himself and then asking questions about them.

Paul plays more independently on climbing frames and spontaneously climbs on novel apparatus in parks. He is able to use the monkey bars independently and is attempting to swing himself but has not mastered the timing required for this skill.

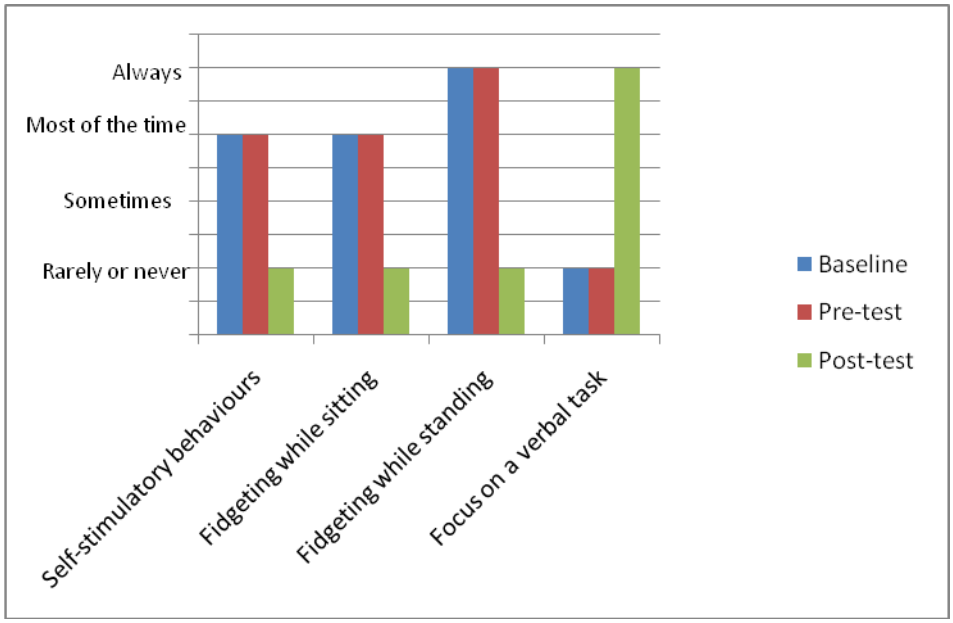

Figure 48 Significant results from behaviour profile for Paul

This component of the behavioural profile was displayed in Figure 48 to indicate the extent of improvement on Paul's behaviour, especially in school. Before the intervention program was implemented these behaviours were highlighted as problem areas for Paul. The results after the intervention program indicate the positive change in behaviour seen by Paul.

Research Question three: Can an individualised adapted physical activity program contribute to positive behaviour changes in children with ASD, specifically in terms of behaviours associated with autism?

The documented improvements in Paul's daily living skills and behaviours associated with autism after the intervention program, confirm the positive contribution that the individualised adapted physical activity program has made.

Journal and Session Sheets: Additional observations

Paul enjoyed his Mighty Muscles sessions as it provided desired physical stimulation. He was excited to begin each session and was constantly requesting to repeat various activities, e.g. animal races at the park, working with weights or obstacle courses. He really enjoyed the sessions when his older sister would join in and he was eager to show her and others the things he had learnt. Often he would finish the session and ask the researcher to check if his muscles had grown. The improved strength and endurance that Paul achieved resulted in improved confidence and an ability to keep up with and sometimes out–do his peers.

Notes from the journal and session data sheets marked various other skills learnt by Paul. These included:

- Cardiovascular training: Paul's stationary activities such as star jumps, skiing and knees up all improved in quality and technique. He learnt how to skip and gallop and hopping on one-leg between targets was mastered and executed with confidence. He was able to skip slowly with a skipping rope but not continuously. His endurance improved so much so that he could join in running to the park, play soccer for half an hour and then run home.
- Strength training: Paul enjoyed working with weights and he was performing comfortably with two kilogram weights at the termination of the project. Overall muscle developmental and definition was observed. With improved strength, Paul enjoyed playing physically boisterous games that required pushing and pulling.
- Balance: Improved strength in his legs and additional practice ensured that balance targets were quickly learnt, mastered and enjoyed. By the end of the intervention program Paul was able to stand on a wooden pole on one leg for a long period of time. Agility and coordination in various activities improved as a result of enhanced balance and strength. He was able to pass a bean bag around and under various body parts while balancing on one leg.

- Ball skills: This part of the program started with the learning of foundation skills with a large ball. Toward the end of the program Paul was mastering aiming, throwing, catching, bouncing and kicking skills with a small tennis ball. He was able to perform all these skills accurately also while on the move.
- Sport skills: Soccer, rugby, tennis and golf were all introduced to Paul. He learnt many of the basic skills and ideas of each game over the period of the intervention and was able to identify the sports. He could participate one-on-one with soccer but needed occasional direction with regards to tackling and scoring goals. He was able to bat a ball between himself and the researcher at the end of the intervention.

Discussion

The benefits of exercise (Haskell, 1987; Rowland & Freedson, 1994; Roberts, 2002; Byrne & Hills, 2007; Cooper & Quatrano, 1999; O'Connor, French & Henderson, 2000) can be clearly seen by the response of Paul to the intervention program. His endurance stamina, muscular strength, balance, flexibility and manual dexterity improved after participating in the intervention program. This can be seen from the post-test assessments results obtained by the M-ABC and BPFT. Paul's difficulties with low muscle tone and mushiness of muscles when palpated were identified when performing gross motor testing on children with autism (Murray-Slutsky & Paris, 2000). After the intervention program was completed, Paul's muscle tone and definition had improved as a result of the positive contribution of the strength training activities included in the program.

Socially Paul is now more receptive and initiates more spontaneous interactions between himself, his peers and sibling. He is more aware of others and objects around him and is more confident in social settings. This confirms the effects that physical activity has on socio-cognitive developments (Pan & Frey, 2006; Jasmin *et al.*, 2009).

The behaviour profile as well as comments made by Paul's parents show a reduction in self-stimulatory behaviours as discussed in Rosenthal-Malek and Mitchell (1997), and Elliot, Dobbin, Rose and Soper (1994). A reduction in aimless wandering coincides with the observations of Whitakers and Saleem (Rosenthal-Malek & Mitchell, 1997). Most of Paul's free time after the intervention was spent in appropriate physical activities and not purposelessly walking/running around. Fidgeting while standing and sitting had reduced and focus on tasks had improved and confirms the findings of Rosenthal-Malek & Mitchell (1997).

As with the other case studies the program was designed to target Paul's individual goals and included tasks that he enjoyed and was successful in, even if appropriate prompting was needed. This resulted in Paul requesting certain activities and performing these activities outside of the session (Baranek, 2002; O'Connor, French & Henderson, 2000).

The skills learnt in the intervention program allowed Paul to interact with peers, during play and physical activity. The APA program has not only benefited Paul physically but has improved his performance and willingness to interact socially. For children with ASD this is an essential goal in physical activity programs (Byrne & Hills, 2007; Pan & Frey, 2006; Reid & O'Connor, 2003).

Recommendations

Through the intervention program it appeared that Paul received the physical stimulation he required and this resulted in the reduced stereotypical behaviour. It is recommended that he continues in a program that provides this stimulation. His development from exhibiting a motor problem to the results achieved in the post-test assessment show his improved motor development.

In order to maintain this and further develop his physical performance, his continual participation with supervision is essential. Improved focus and interaction between peers also encourages Paul to remain engaged. Continued sport education will give Paul the skills to use his stronger motor skills and enhanced fitness levels in a social setting. Adding to his existing social skills

development program, this will provide opportunities to participate in age-appropriate tasks with his peers.

CHAPTER SEVEN

CONCLUSION

Comparison of three case studies

Motor Abilities

The motor abilities of the three participants with ASD were tested by the Movement Assessment Battery for Children (M-ABC). Results for the three children show an improvement in all three components, manual dexterity, ball skills and balance after the intervention program was completed.

Figure 49 shows the positive contribution the intervention program made to the motor proficiency of the subjects as indicated by the total item scores for the M-ABC. A decreased item test score result indicates an improvement in the performance in the test.

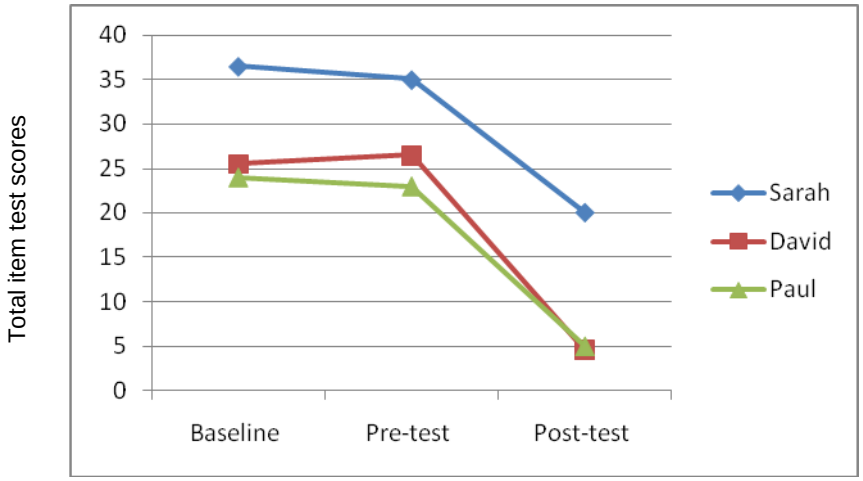

Figure 49 Total item test scores for the M-ABC for the three case studies

The slight variation between the baseline and pre-test assessment results, with a drastic decreased in scores for the post test assessment is a clear indication of the positive contribution of the adapted physical activity (APA) program on the motor skills of these children with autism.

Physical Fitness

The three children with autism were assessed in terms of physical fitness by selected items on the Brockport Physical Fitness Test (BPFT). Results for the BPFT similarly show improvement for all three subjects in each physical fitness component.

A comparison of the intervention program's contribution to the physical fitness levels on all three children with ASD can be observed for:

- Aerobic capacity,
- Muscular strength and endurance including the arm hang, isometric push up and curl up and
- Flexibility including Sit and Reach test.

Aerobic Capacity (see Figure 50)

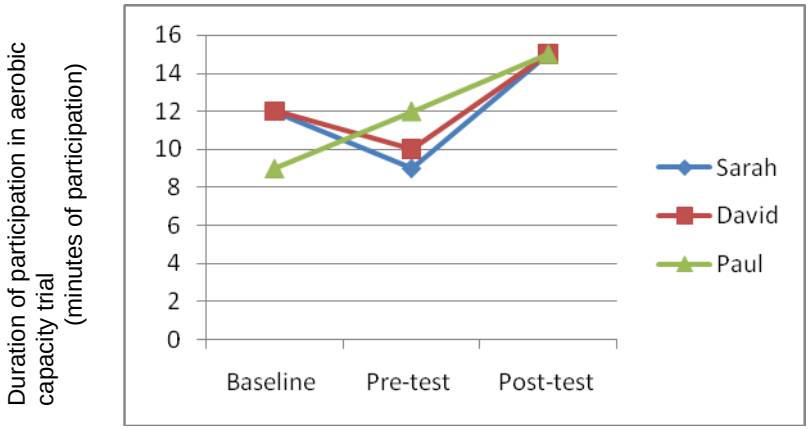

Figure 50 Aerobic capacity results for all three case studies

Although both Sarah and David performed more poorly in the pre-test assessment, all three children were able to complete the post-test assessment showing enhanced endurance stamina. The qualitative observations made for this test also indicate more physically fitter and more relaxed subjects with less strain of their cardiovascular systems in the post-test assessment.

Muscular Strength and Endurance

Arm hang (see Figure 51)

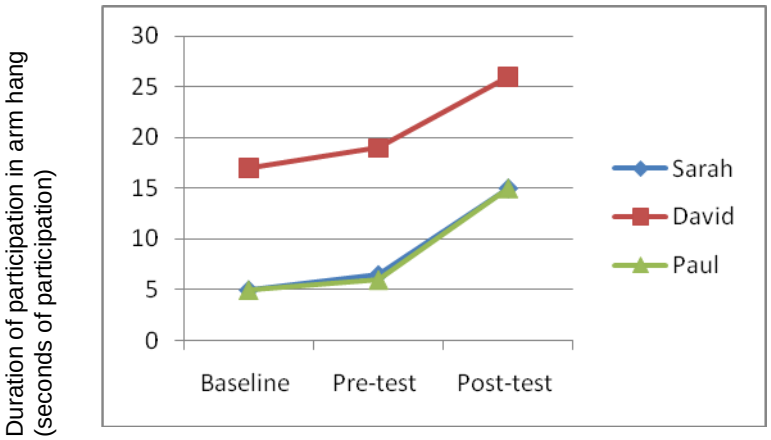

Figure 51 Arm hang results for all three case studies

An improvement in performance in this test can be seen for all subjects after the implementation of the intervention program. Even though David was physically more competent in the baseline and pre-test assessment, when compared to Sarah and Paul, he still improved his arm strength through the intervention program.

Isometric push up (see Figure 52)

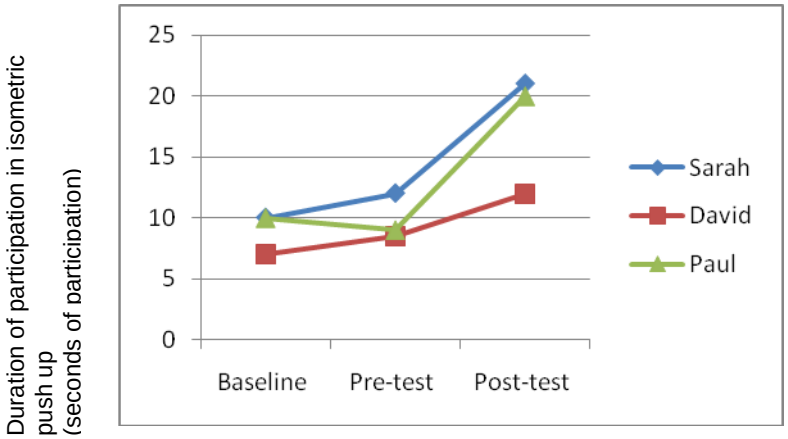

Figure 52 Isometric push up results for all three case studies

Both Sarah and David slightly increased their time spent in the test between the baseline and pre-test assessment. However, the increased performances in the post-test show the positive contribution that the intervention program had on their muscular strength and endurance. Paul's pre-test performance was slightly

lower than his baseline assessment but, similarly to the other subjects, his post-test assessment shows a significant increase, demonstrating the effect of the intervention program.

Curl up (see Figure 53)

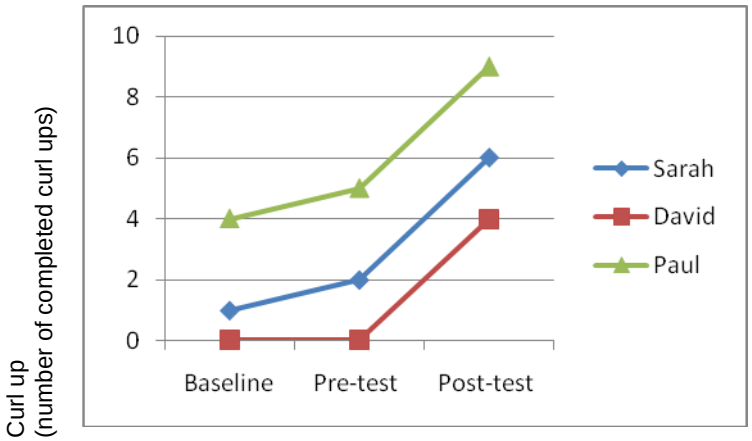

Figure 53 Curl up results for all three case studies

Although Paul's performance was noticeable superior to David and Sarah, all three subjects demonstrated definite improvements in their ability to complete this test. The intervention program for all subjects focused on improving core and abdominal strength and this contribution is clearly evident in the post-test.

Flexibility

Sit and Reach test (see Figure 54)

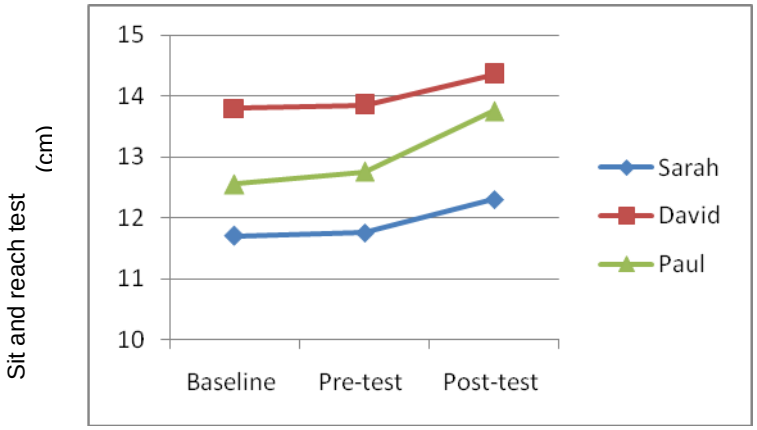

Figure 54 The mean sit and reach results for all three case studies

Figure 57 shows the positive contribution of the intervention program, which included stretches in every “Mighty Muscles” session, on all three subjects. David’s performance was superior to Paul and Sarah in all three assessments, but the most significant improvement after the implementation of the intervention program can be seen in the post-test results of Paul.

In order to compare the three subjects graphically the mean value for the Sit and Reach test on the left and right leg was combined and calculated for each subject. The vertical axis was also changed for this graph to display the improvement more clearly, i.e. the vertical axis starts at ten and not zero.

Social Play, Daily Living Activities and Overall Behaviour

Sherrill UVA-UPE Social Play Inventory

The Sherrill UVA-UPE Social Play Inventory was used to assess the social play behaviour of the three subjects. An improvement in these social play behaviours was evident in the post-test assessments for Sarah, David and Paul. However, the positive contribution that the intervention program had on each child was exhibited differently by each child. When comparing the three children with autism similar improvements in social play behaviour can be seen in:

- Spontaneous unoccupied play,
- Reduction in self-stimulatory behaviours,
- Improved object and person preference,
- Heightened awareness and response to stimuli,
- Confident and spontaneous imitation of peers,
- Improved awareness and interaction with peers and
- More developed cooperative play (this improvement was only seen in Paul and David).

Behavioural Profile

The behavioural profile used to assess the three children with ASD focused on daily living skills, levels of arousal and attention, self-stimulatory behaviours, physical play targets, coping and frustration levels, responses to different environments, maladaptive behaviours and locomotion. Results after the

implementation of the intervention program show significant improvements in specific areas for each child and exhibit the positive contribution the program had on the specific behaviours associated with autism displayed by each subject.

When comparing the three subjects, the beneficial role the intervention program had on Sarah, David and Paul's behaviours can be observed in the following:

- The distinct decrease in self-stimulatory behaviours and maladaptive behaviours (in Sarah's case),
- More appropriate and constructive use of free time, especially demonstrated in increased voluntary participation in physical activity,
- Improved focus for longer periods of time with higher levels of arousal and attention,
- Reduction in fidgeting and unusual movements while sitting, standing or in locomotion,
- Improved ability to sit or stand appropriately for longer period of time,
- Advanced coping skills and lower levels of frustration and
- Improved daily living skills, especially for Sarah in sleeping and eating patterns.

Strength and Weaknesses of the Study

The effectiveness of the program was based on single case study reports which were both a strength and weakness of the study. The collection of extensive quantitative and qualitative data provided a holistic understanding of the children involved in the study. This also allowed for the intervention program to be designed according to the child's specific goals, preferences and behaviours. The case study approach placed the real-life phenomenon within its real life context and the effect of the intervention program within this was clearly evident.

With limited studies done on the contribution of an APA program on children with autism, a strength of this study is the vital information it provides on the design, guidelines and implementation of an effective APA programs for this

population. During this study insight was gained on how to implement such programs and examples of effective practice and guidelines for individualizing APA programs were developed.

The time provided for the implementation of the study and the continual assessment and updating of specific targets allowed for each child to learn, develop and master a wide range of physical abilities, skills and fitness. The influence of the many variables that affect children with autism are reduced when the length of the study is sufficient.

External variables that can affect the results of the test components, such as natural physical development and maturation, were considered when analysing the results. However, the majority of the results achieved displayed surprising improvements in the test components.

Since autism presents itself differently in each child, this makes the application of the same intervention program to all children with autism very difficult. Some children with autism may not have the language comprehension skills or be comfortable in a physical activity setting. In order to achieve the results seen in this study the intervention program will have to be adapted to suit the capabilities and specific behaviours of each child with autism. The differences in the intervention program for each child limit the ability to make generalisations for the population.

Although the results of the study were graphed and findings were discussed based on visual inspection by the researcher, qualitative observations provided additional support to the assumptions made based on the graphical examinations.

The instruments used for testing the motor abilities and physical fitness of the children contain instructions that were not initially familiar or understood by the children in the study. Adaptations to the instructional implementation assisted in ensuring that the child's physical components were assessed and that their lack of understanding did not influence their results, e.g., the researcher would model the test as opposed to saying "hold as long as possible".

Once the intervention program was completed and the children had received no supervised physical stimulation for a lengthy period of time, an additional assessment would have provided further information on the contribution that this APA had on children with ASD. This would have determined if the abilities acquired in the program and the improved physical fitness was maintained. Regression in social play and behaviour determined through additional testing would strengthen the need for the maintenance of the intervention program.

With reference to the above, four months after the intervention program had ended, the researcher was contacted by Paul and David's parents. They all expressed the change noticed in their children since their participation in "Mighty Muscles" had stopped. They mentioned that self-stimulatory behaviours had returned to pre-intervention levels and focus and attention levels had decreased. Social play behaviours and levels of physical fitness had worsened and their children were verbally requesting for the re-commencement of the program.

As a result of this "Mighty Muscles" was re-instated and is still continuing presently. Other families with children with autism and other developmental delays have approached the researcher. Currently there are ten children participating in "Mighty Muscles" sessions adapted specifically for their goals and functionality. There are also more children on a waiting list for when additional staff can be trained.

Recommendations for Researchers and Practitioners

It is recommended that for a future study the number of participants is increased in order to assess the contribution that this intervention program would have on children with different behavioural symptoms. With a greater sample number the results achieved for the study will be more easily applied to the population. Another recommendation for future research would be to assess the long-term retention of the gains identified as a result of the intervention program. Further study on the assessment instruments needs to be completed in order to determine reliability and validity data for children with autism.

Further research is needed in the designing and assessing of a testing instrument that is specifically applicable and suitable to the core features of autism and its associated deficits. This will ensure that when the motor performance of children with autism is assessed, the assessment instrument will have considered the many facets of the disorder. For example limited communication or sensitivity to sensory stimulation.

Future researchers attempting to reproduce this study need to consider the relationship that the researcher had with the subjects involved. Several years of interaction prior to the study provided the researcher with abundant knowledge of the child's specific preferences, behaviours and capabilities. It is therefore essential for future studies to ensure a period of time in which the researchers observe, interact and understand the subjects involved. This becomes vital when the APA program is being designed with a specific child in mind. The individual nature of autism also demands that each participant is observed and understood individually.

The curriculum for each intervention program should be designed not only with the child's motor performance targets as a guideline, but also the child's intrinsic and extrinsic incentives. Physical activities in the intervention program should be designed and adjusted in order to attend to the child's personal incentives. This will ensure compliance from the child and a positive experience for the child in the program.

Necessary adaptations in the instructional component of the testing instruments should be considered and decided upon, prior to the assessment. These adaptations can only be decided upon once the researcher is familiar with the individual nature and characteristics of the participant and the disorder. This principle also applies to the instructional components of the intervention program. Directions during the intervention programs should be at a level which is appropriate and comprehensible for the child involved.

Continuous assessment of the child's performance in the each of the intervention components is vital in order to ensure that the child continues to develop in each component and is constantly challenged. Activities that are complicated and above the individual's level of competency should be broken

down to more simple tasks or should be assisted or prompted methodically to ensure success in the task.

Summary

Three children with autism, aged between three and eight years old, volunteered to participate in an APA program designed to enhance motor performance. The APA program was designed and updated using the specific goals, preferences and capabilities of each individual child.

The study determined the effects of this APA program on the motor abilities, specifically manual dexterity, ball skills and balance, and the physical fitness, including aerobic capacity, muscular strength and endurance and flexibility on children with ASD. In addition to this the study determined effects of the APA program on social play behaviour and behaviours associated with autism. The intervention program was administered for 20 weeks, three times per week for 50 minutes per session.

Through the collection and analysis of quantitative and qualitative data in a baseline, pre-test and post-test assessment the researcher was able to conclude the following:

1. An individualised APA program contributed positively to the motor abilities of all three children in the study,
2. An individualised APA program contributed positively to the physical fitness of all three children in the study, and
3. An individualised APA program contributed to positive changes in behaviours associated with autism and social play behaviour.

In conclusion the adapted physical activity program has a positive, beneficial effect on motor performance and behaviour of children with autism spectrum disorder.

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APPENDIXES

Appendix A

Sherrill-University of Virginia Adapted Physical Education Social Play Behaviour Inventory

Child's name:_____ **A= Always**

Child's age: _____ **M= Most of the time**

Carer's name: _____ **S= Sometimes**

Relationship to child:_____ **R= Rarely or never**

Date: _____

	A	**M**	**S**	**R**
Unoccupied				
Show no spontaneous play				
Makes no response				
Show no object or person preference				
Makes stereotyped or repetitive movements				
Pounds, shakes, or mouths objects without purpose				
Self-stimulates				
Wanders about aimlessly				
Solitary/Exploratory				
Reacts to stimuli (approaches or avoids)				

Reacts to persons or objects				
Understands object permanence (peek-a-boo)				
Explores body parts				
Explores objects/toys				
Shows object preference				
Shows person preference				
Parallel				
Establishes play space near others				
Shows awareness of others but doesn't interact				
Plays independently with own things				
Plays on some playground apparatus as others				
Follows leader in imitation games/ obstacle course				
Associative/Interactive				
Initiates contact or play with others				
Talks, signs, or gestures to others				
Imitates others				
Rolls/hands object to another without being asked				
Retrieves objects for another without being asked				
Offers to share objects or toys				
Engages in make-believe play with others				

Takes turns talking and listening				
Cooperative				
Participates in small-group games				
Sustains play in group of 3 or more for 5 minutes				
Follow simple game rules				
Understands stop and go				
Understands safety zone, boundary line, base				
Understands ‘It’ and ‘not it’				
Understands game formations				
Plays games demanding one role				
Switches role to achieve game goals: hide vs seek				

Appendix B

Behavioural Profile (Developed by Researcher)

Child's name:_____ **A= Always**

Child's age: _____ **M= Most of the time**

Carer's name: _____ **S= Sometimes**

Relationship to child:_____ **R= Rarely or never**

Date: _____

	A	**M**	**S**	**R**
Daily Living Activities				
Does your child eat happily at regular intervals?				
Does your child enjoy a variety of food?				
Is it difficult to feed your child a necessary amount?				
Does your child look for additional food after meal time?				
Does your child skip meals?				
Will your child try novel food easily?				
Does your child sleep without waking during the night?				
Does your child go to sleep at the same time each night?				
Does your child battle to fall asleep?				
Is it difficult to put your child to bed?				
Would your child put him/herself to bed?				

Is your child very alert and energetic at bed time?				
Does your child wake up on his/her own in the morning?				
Do you need to persistently motivate your child to wake up in the morning?				
Is your child happy as he/she wakes up?				
Does your child nap during the day?				
Is your child hyper-active?				
Is your child consistently moving during his/her free time?				
Does your child need help to sit without fidgeting?				
Is your child able to sit still for a lengthy period of time?				
Does your child choose to play outside in the garden?				
Does your child enjoy watching tv?				
Does your child sit with cross legs comfortably?				
Does your child sit with legs underneath him/her?				
Does your child sit with legs parallel next to him/her?				
Does your child sit with a straight back unassisted?				
Does your child ‘hunch over’ while sitting?				
Is it difficult for child to stand for a period of time?				
Can your child stand still without fidgeting?				
Does your child flop onto the ground while standing?				

Does your child walk appropriately from one area to another?				
Does your child perform unusual movements while in motion?				
Does your child run comfortably?				
Does your child enjoy playing on apparatus?				
Can your child hang from a bar unsupported?				
Is your child able to use ‘monkey bars’ independently?				
Can your child swing him/herself?				
Can your child cope with new situations/people?				
Does your child attempt new and difficult tasks?				
Does your child become frustrated quickly?				
Is your child patient?				
Does your child understand ‘no’?				
Does your child tantrum?				
Is your child self-injurous?				
Is your child destructive to surrounding environment?				
Is your child disruptive?				
Is your child aggressive?				
Does your child demand your attention?				
Is your child upset if he/she cannot obtain your				

attention?				

General comments with regard to your child's behaviour. Is there a behaviour that your child exhibits that you find inappropriate and unnecessary? If so please list these behaviours and any possible triggers of these behaviours. Please also comment on the frequency and the duration of these behaviours?

_____
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Appendix C

STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

My name is Leanne Ferguson and I am currently completing my Masters degree in Sport Science at Stellenbosch University. My research is focused on the impact of an adapted physical activity programme on children with autism and I would like to ask your permission to include your child to participate in the programme.

PURPOSE OF THE RESEARCH

The purpose of the study is to establish the impact of participation in a specific individualized adapted physical activity program on the motor performance of children who have been diagnosed as being on the autistic spectrum. A secondary function is to depict how participation in the program may influence behaviors associated with autism.

The specific aims of the study are to look at the effects the adapted physical activity programme has on gross motor (balance and ball skills) skills, fine motor skills (hand strength and dexterity) and physical fitness (endurance, muscle strength and flexibility). Also to determine if this adapted programme will influence behaviours associated with autism.

PROCEDURES

I will use a case study approach. Each child who participates in the programme will receive an individual adapted physical activity programme, presented in 50 minute sessions three times per week for a period of 20 weeks. I will be the instructor for all of these sessions and will ensure that the physical activities offered to your child are appropriate for his/her level of skill and physical fitness.

I will test your child's level of motor development at the beginning and end of the 20-week period in order to determine if participation has resulted in any improvements in motor performance and if it has had an influence on behaviour.

I will also ask you to assist me in developing an overall motor performance and behaviour profile for your child. I will ask you to respond to a series of questions about your child's behaviour and motor abilities. (The Sherrill-University of Virginia Adapted Physical Education Social Play Behaviour Inventory and the Behavioural profile

developed by the researcher will be used). This will give us a profile that describes your child prior to the programme. Then, during the programme, I will ask you to respond to the similar questions on a regular basis in order to determine if there are any changes in how your child behaves when he/she is involved in a motor development programme, or after he/she has completed the programme.

POTENTIAL RISKS AND DISCOMFORTS

It is always possible that a child may experience an injury when participating in any physical activity programme. This risk is greatly reduced in this study since the children will not be playing with each other, but only with me. This means I can effectively control most of what is happening in the activity sessions. We also play with special equipment rather than official sport equipment. This equipment, such as sponge balls and bean bags, are much easier for children to handle safely.

In the unlikely case of an accident, I am qualified in first aid and teach with a first aid kit and my cell phone with me. I have the number of emergency services on my clipboard should a health incident occur.

POTENTIAL BENEFIT

Participation in the physical activity programme will be delivered in a spirit of playfulness and will emphasize enjoyment. In this positive environment, it is anticipated that your child will improve in some of his/her motor performance - confidence as a result. qualities and may experience improvement in self

If the programme is successful in contributing to a more positive behavioural profile in terms of behaviours associated with autism for your child, a contribution will be made to the educational body of knowledge about the value of participating in physical activity programmes.

PAYMENT FOR PARTICIPATION

There is no payment for participation in the study. My professional services will be provided at no cost to you.

CONFIDENTIALITY

I would like to emphasise that because this is a case study, not only is your child treated as an individual and provided with a custom programme, but he/she will not be compared to any other children. You will receive a confidential report from me that will

describe how your child progressed throughout the programme. In the formal report of my research, no mention will be made of your child's name or his/her school in order to protect his/her anonymity.

PARTICIPATION AND WITHDRAWAL

If you would be willing to have your child participate in this study, it is important to remember that you may withdraw your child from the study, at any time, with no reason required. If deemed necessary, your child's participation in this project will be terminated be the researcher.

IDENTIFICATION OF INVESTIGATORS

If you have any questions regarding**,** or concerns about the research, please feel free to contact:

Principal Investigator: Leanne Ferguson

Department of Sport Science, Stellenbosch University
0741 308 374

leaferguson@gmail.com

Study leader:: Ms Corne Rossouw

Department of Sport Science, Stellenbosch University

021-8084733

cr@sun.ac.za

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and your child may discontinue participation without penalty. You are not waiving legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Maryke Hunter-Hüsselmann (hsl3@sun.ac.za)**,** Research Coordinator: Human and Social Sciences Admin B, Room B3207. Phone: (021) 808 4623; Fax: (021) 808 4537 at the Unit for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was provided to me by Leanne Ferguson in English at a meeting between us and the principal researcher. I am in command of the English language. We were given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent to allow my child to be given the opportunity to participate in this study,

_____

Name of Child

_____

Name of Parent or Legal Representative

_____ _____

Signature of Parent or Legal Representative **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to_____ (name of parent or legal representative). He/she was encouraged and given ample time to ask me any questions. This presentation was conducted in English. If the parents/legal representative was positive about his/her child's participation, they were asked to sign the consent form above.

_____ _____

Signature of Investigator **Date**

NB: A copy of this form is given to the parent/legal representative and a copy is kept by the investigator.

Appendix D

Session Target Sheet

Cardio									
Running									
Skipping									
Stationery									
Games									
Strength									
Upper body									
Lower body									
Core									
Back									
Balance									
Static									
Dynamic									

Unstable environment									
Ball skills									
Catching									
Bouncing									
Throwing									
Aiming									
Bat									
Sport's Education									
Soccer									
Other									

Appendix E

Target Assessment

Case study:…Sarah……

Date of assessment:……Week 1……

Cardiovascular training:

- Very low physical activity levels and fitness
- Poor body control during stationary tasks
- Tires quickly & needs lengthy recovery
- Enjoys trampoline & running in garden
- **Target** sustaining physical activity for periods of 30 seconds
- **Target** develop basic skills needed for stationary tasks, do legs first.
- **Target** record recovery periods needed and decrease weekly by 10sec increments

Muscular strength training:

- Battles to support body weight with arms
- Weak breathing skills when straining
- Low muscle tone
- **Target** weight-bearing exercises on hands and elbows
- **Target** core stabilizers, basic crunch
- **Target** basics to squats and lunges

Ball skills/ Sport skills:

- Very weak ball skills include tracking, aiming, catching and throwing
- Response time is slow
- Not participating in any sports. No knowledge of sports.
- **Target** using a large, light ball start with the basics of catching and tracking
- **Target** work on activities that improve response time
- **Target** introduce kicking and stopping a moving ball (large)-Soccer

Balance & coordination targets:

- Very poor compensatory skills in balance, no posture or body control
- Dyspraxic
- Battles to cross the midline or imitate complex strings
- **Target** start balancing one leg with an aid at shoulder level to improve posture
- **Target** strengthen muscles of legs and arms
- **Target** novel imitation strings to follow including imitating with objects

Flexibility & agility targets:

- Very tight hamstrings
- Displays high levels of discomfort in stretching tasks
- Battles to change direction or pace while running
- Can't jump from one leg to another
- **Target** stretching at the start and end of session, especially hamstrings
- **Target** practice running at different speeds for short periods of time

General comments:

- On-task focus is weak, with frequent self-stimulatory behaviours
- Enjoys working on the exercise ball
- **Target** design tasks that require full attention for 30 seconds
- **Target** explain concepts "as long as possible" & "fast as possible"

Appendix F

Target Assessment

Case study:…Sarah……

Date of assessment:……Week 16……

Cardiovascular training:

- Improved level of fitness (sustained for 10mins)
- Recovery period is now completed in under 25 seconds
- Is incorporating both arms and legs in stationary exercises
- Swimming is still very popular
- **Target** increase distance run on the beach and in obstacle courses
- **Target** focus on breathing through the nose and not panting
- **Target** introduce novel stationary activities like burpees or bear crawls

Muscular strength training:

- Comfortable the 1.5kgs for 2 sets
- Holding breath when fatigue sets in
- Has mastered basic pilates core exercises
- **Target** introduce 2kg weight for first set
- **Target** introduce pilates on exercise ball, work on breathing
- **Target** Therabands to be included into legs, not only arms

Ball skills/ Sport skills:

- Competent in catching, batting, kicking, throwing and aiming with medium ball
- Is able to dribble and attempt a kick at goals, aiming still off
- Plastic tennis racquet is mastered
- **Target** introduce smaller ball, (tennis)
- **Target** start complex bounce-catch tasks
- **Target** sports: swimming strokes and heavier bat for tennis

Balance & coordination targets:

- Balancing on exercise ball is much better
- Balance is disrupted in moving balance tasks once fatigue sets in
- **Target** introduce skateboard as novel balancing environment
- **Target** use more dynamic balance tasks in cardio training
- **Target** introduce passing bean bag under knee and behind back (one leg lifted)

Flexibility & agility targets:

- Is able to hold on to top of feet while sitting
- Not complaining at all!
- Hop scotch is nearly perfect
- **Target** aim the nose down to the knee while stretching
- **Target** try stretching muscles in novel way i.e. use a towel
- **Target** do zigzag running up and down a hill

General comments:

- Manual dexterity exercises are a target this week
- Once session finished allow Sarah to swim
- **Target** document if there are any observed behaviours
- **Target** work on swinging independently

Appendix G

Target Assessment

Case study:…David……

Date of assessment:……Week 1……

Cardiovascular training:

- Physically busy child, but no appropriate physical activity observed
- Tires quickly & needs lengthy recovery
- Enjoys climbing on play apparatus, very slowly though and hopping
- Poor timing and control over movements in stationary exercises
- **Target** sustaining physical activity for periods of 30 seconds
- **Target** develop basic skills needed for stationary tasks, do legs first.
- **Target** record recovery periods needed and decrease weekly by 10sec increments

Muscular strength training:

- Unable to support body weight with arms
- Weak breathing skills when straining
- Low muscle tone
- **Target** weight-bearing exercises on hands and elbows
- **Target** core stabilizers, basic crunch
- **Target** basics of squats and lunges

Ball skills/ Sport skills:

- Tracking is very poor, battles to follow a slow moving object
- Very weak ball skills including aiming, catching and throwing
- Not participating in any sports. Can tell you very basics about sports
- **Target** do tracking exercises sitting down with slow moving objects
- **Target** using a large, light ball start with the basics of catching and tracking
- **Target** introduce kicking and stopping a moving ball (large)-Soccer

Balance & coordination targets:

- Very poor compensatory skills in balance, no posture or body control
- Battles to cross the midline or imitate complex strings
- Observed shaking and tremors in legs/arms while balancing-weak
- **Target** start balancing one leg with an aid at shoulder level to improve posture
- **Target** strengthen muscles of legs and arms
- **Target** use stress balls and rolls balls in the feet-target wrists and ankles

Flexibility & agility targets:

- Very tight hamstrings
- Displays high levels of discomfort in stretching tasks
- Unable to control speed of running or able to stop suddenly
- Can't jump from one leg to another
- **Target** stretching at the start and end of session, especially hamstrings
- **Target** practice running at different speeds and stopping suddenly

General comments:

- Very physically busy David battles to stand or sit still even for short period of time
- Focus on tasks is poor and self-stimulatory behaviours are present such as hopping and jumping
- **Target** design tasks that require full attention for 30 seconds
- **Target** explain concepts "as long as possible" & "fast as possible"
- **Target** practice being still for a short time, slowly build that time up.

Appendix H

Target Assessment

Case study:…David……

Date of assessment:……Week 16……

Cardiovascular training:

- David is spontaneously doing obstacle courses and riding his bike
- Is able to participate in activity for 12 minutes before asking for a break
- He is physically less stressed by the exercises and is breathing easily
- **Target** run full boundary of the park
- **Target** increase time spent doing stationary tasks without technique faults
- **Target** do full cardio session on his bicycle

Muscular strength training:

- Mastered 1,5kgs
- Marked definition in arms and core
- Using his legs more effectively during climbing
- **Target** introduce 2kg medicine ball
- **Target** start pilates core exercises
- **Target** use additional weights with legs exercises

Ball skills/ Sport skills:

- Aiming mastered with medium ball
- Response time in returning batted ball is slow
- Concept of goalie still needs explaining but attacking much better
- **Target** introduce small ball (tennis)
- **Target** use lighter ball for tennis rally
- **Target** refresh complex bounce-catch sequences

Balance & coordination targets:

- Balancing on skateboard has improved but still only very slowly
- Is able to perform arm activities while balancing on one leg
- Introduce hop scotch
- **Target** try picking objects up while balancing on one leg
- **Target** work on hopping onto different legs in different directions

Flexibility & agility targets:

- Able to touch the floor
- Agility ladder still needs practicing especially towards the end
- **Target** taking nose down to knees while stretching
- **Target** jumping different directions onto marks on the floor

General comments:

- Record any inappropriate behaviours
- Work on confidence on monkey bars
- **Target** hanging from different objects and falling down
- **Target** using clear language when explaining activity he wants
- **Target** watch a soccer match

Appendix I

Target Assessment

Case study:…Paul……

Date of assessment:……Week 1……

Cardiovascular training:

- Physically busy child, free time spent running up and down or wandering aimlessly
- Tires quickly & needs lengthy recovery
- Enjoys trampoline & running, doesn't choose to play on climbing apparatus
- Poor body control and timing in stationary exercises
- **Target** sustaining appropriate physical activity for periods of 45 seconds
- **Target** develop basic skills needed for stationary tasks, do legs first.

Muscular strength training:

- Can support himself on his arms and hands but is not stable in the position
- Able to do a sit up but tires quickly
- Slightly low muscle tone
- **Target** use 0.5 & 1kg free weights, increase time spent on arms and hands
- **Target** core stabilizers, basic crunch
- **Target** basics of squats and lunges

Ball skills/ Sport skills:

- Needs overall focus on tracking, catching, throwing and bouncing
- Demonstrates no focus on ball or ability to use different throwing techniques
- Does playball once a week, can't show me exercises done there
- **Target** do tracking exercises before doing catching tasks
- **Target** using a medium-large ball, do basics of catching, throwing & bouncing
- **Target** introduce kicking and stopping a moving ball (large)-Soccer

Balance & coordination targets:

- Very poor compensatory skills in balance, no posture or body control
- Battles to cross the midline or imitate complex strings
- Observed shaking and tremors in legs/arms while balancing-weak
- **Target** start balancing one leg with an aid at shoulder level to improve posture
- **Target** strengthen muscles of legs and arms
- **Target** use stress balls and rolls balls in the feet-target wrists and ankles

Flexibility & agility targets:

- Very tight hamstrings, expresses discomfort
- Unable to touch shins while sitting or standing
- Unable to control speed of running or able to stop suddenly or jump from one leg to another
- **Target** stretching at the start and end of session, especially hamstrings
- **Target** practice running at different speeds and stopping suddenly

General comments:

- Although Paul is active, no purpose to activity, wandering aimlessly
- Self-stimulatory behaviours include running/pacing, jumping/hopping
- Focus on tasks is poor, fidgets constantly (sitting/standing)
- **Target** design tasks that require full attention for 30 seconds
- **Target** explain concepts “as long as possible” & “fast as possible”
- **Target** practice being still for a short time, slowly build that time up.

Appendix J

Target Assessment

Case study:…Paul……

Date of assessment:……Week 16……

Cardiovascular training:

- Voluntarily choosing appropriate aerobic and physical activities
- Recovering in under 25 seconds
- Able to sprint for 300metres
- **Target** full loop of park, running with no rests
- **Target** incorporate sprints into endurance tasks
- **Target** refresh mastered stationary exercises

Muscular strength training:

- Loves core work on the pilates exercise ball
- Posture is greatly improved on above the shoulder weight exercises
- Great muscle definition in upper arms and core
- **Target** increase sets from 3- 4 in weights
- **Target** introduce free weights into core and leg exercises
- **Target** focus on back and glutes

Ball skills/ Sport skills:

- Aiming into goal on the floor very good
- Dribbling and attacking mastered, need to practice in game setting
- Response time has improved a lot
- **Target** combine small and medium balls together in tasks
- **Target** work on aiming at a target on a wall, then while moving
- **Target** throw ball against wall, spin around and catch ball-no bounce

Balance & coordination targets:

- Good balancing on the balance board
- Skipping with rope is much improved
- **Target** introduce skate board, stationary then moving slowly
- **Target** while balance on one leg, tap bottom of foot in front then behind the body
- **Target** increase pace of skipping with rope

Flexibility & agility targets:

- Very close to touching top of foot while standing and sitting
- Comfortable to jump in a different directions without warning
- Great work on agility ladder
- **Target** introduce stretching with Therabands
- **Target** try hopping (one-leg) in different directions on demand

General comments:

- Record any inappropriate behaviours
- Choosing appropriate physical activities
- Great reports from school about sitting still
- **Target** introduce novel activities to do outside like washing the car
- **Target** do manual dexterity tasks to assess sitting still
- **Target** incorporate peers into physical activity tasks

Appendix K

Session Plan

Case study:…Sarah……

Cardiovascular training:

- Trampoline: 7 minutes twice in the session
- Sprints (slight hill): 4 sprints per set, 2 sets in the session
- Do stationary exercises: work on star jumps with arms

Muscular strength training:

- Pilates ball: 15 minute session in the ball
- Focus on core and upper body
- Do stair work with med-heavy bean bags. (10 minutes)

Ball skills/ Sport skills:

- Aiming: throwing med ball against goal on a wall
- Kicking at a target.
- Catching and throwing with med ball. No high passes
- Swimming: improve technique and encourage to swim length of pool

Balance & coordination targets:

- Work on keeping arms still balancing on one leg.
- Crossing the midline with arms
- Walking on a balance beam without assistance
- Follow string of movements

Flexibility & agility targets:

- Hopping with non-dominant legs
- Hopping on the move but alternating legs
- Sustaining stretch positions for longer period of time
- Hamstrings: touching pass ankle with straight legs

General comments:

- Really enjoying bubbles-high reinforcer
- Start and finish with deep pressure
- Working on hop scotch.

Appendix L

Session Plan

Case study:…David……

Cardiovascular training:

- Work on changing speeds while running.
- Need to do a 10 minute continuous jog (to the park)
- Skipping rope: try 15 in a row

Muscular strength training:

- Work on upper body on the monkey bars: pull ups with assistance
- Lunging on same leg (20 reps, 2 sets)
- Core: basic Pilates exercises

Ball skills/ Sport skills:

- Kicking into a goal: with soccer ball
- Defending his goal/ ball
- Work on tracking of the ball before catching activities: medium ball
- Catching a ball while running

Balance & coordination targets:

- Work on remaining still during balancing tasks: no fidgeting
- Balancing on unstable base without assistance: use stability board
- Imitating string of movements: but wait for me to be finished.

Flexibility & agility targets:

- Hopping: being able to stop, keep balance and start again
- Changing directions quickly while running
- Hamstring: needs to be stretched with assistance

General comments:

- Focus on stuck in the mud
- Allow sister to join in for the last 10 minutes.

Appendix M

Session Plan

Case study:…Paul……

Cardiovascular training:

- Do circuit with 4 activities: star jumps, stationary ski, double leg hop, high knees (attempt 15 minute participation)
- Cycle to the park

Muscular strength training:

- Increase to 1kg weights and focus on shoulder and chest muscles
- Enjoys working with weights so do 4 sets
- From prone position work on quads and gluts

Ball skills/ Sport skills:

- Batting with heavier bat and tennis ball. Record longest rally.
- Bouncing while jogging slightly
- Tackling in soccer and basketball

Balance & coordination targets:

- Balance on one leg: leg extension and forward dip
- Bi-lateral exercise: using lower limbs

Flexibility & agility targets:

- Work on placing nose to knees with straight legs
- Agility ladder: introduce
- Yoga : basic exercises

General comments:

- Ensure Paul is drinking water.
- Focus on Piggy in the Middle, while running.
- Really enjoys soccer on the field