The motor development of HIV positive and HIV negative children aged three to six years, residing in institutions and in foster care

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Declaration

I, Nailah Davids, hereby declare that this thesis is my own work and has not been submitted for a degree at any other university.

All resources I have used or quoted are acknowledged by a complete list of references.

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Abstract

Aim: To compare the motor development of children aged 3-6 years with HIV/AIDS in institutions and in foster care using the Peabody Motor Developmental Scale (PDMS II).

Objectives: A description of socio-economic conditions of the children, to compare the health status of HIV positive children, to establish and compare developmental quotients of children across two care-giving environments and compare performance of children with and without HIV, to determine to what extent developmental quotient changes over a six-month period and establish which factors predict performance.

Study Design: A descriptive, analytical, prospective, longitudinal study design was used.

Participants: 44 children participated in the study at baseline. The children were recruited from four institutions in Cape Town and from community outreach programmes supporting foster parents. Six months later 37 children were tested.

Instrumentation: The PDMS II was used to assess and score motor development of all participants. A questionnaire was administered prior to data collection to gather demographic and medical information and placement information. Height and weight were recorded using a tape measure and electronic scale and Body Mass Index was calculated and percentiles calculated using the Centre for Disease Control (CDC) norms.

Procedure: Data was collected from September 2006 to June 2007. Developmental assessments were conducted at baseline and six month later.

Data Analysis: All data was entered into and analysed using the Statistica Version 7 Software. Descriptive statistics were used to present frequencies and demographic data. Other tests used were Chi-squared test for associations, the Mann-Whitney U test was used to test if there was a significant difference in the rank ordering of data that were not normally distributed. For numeric, normally distributed data, the Kolmorogov Smirnoff test was used. Dummy variables were created for residence

and HIV status and multiple regression analysis was used. A .05 level of significance was used throughout the study.

Results: 25 resided in institutions and 19 in foster-care with a mean age of 52.75 months (SD = 10.88; Range = 35.7 – 73.8 months). Twenty one children had HIV. No difference existed in gender or HIV status. The HIV positive children were significantly delayed compared to the HIV negative group.

HIV status and place of residence emerged as a predictor of TMQ at baseline. However, place of residence lost predictive value at six months. In HIV positive children, only place of residence was predictive of TMQ.

Discussion/Conclusions: HIV children were significantly delayed. ARVT access was well managed; however, fostered children had limited access to rehabilitation services. Overall performance may have been influenced by changes in environment, the amount of structured play and stimulation activities in the institutions and at play groups at follow-up.

Recommendations: Parental, family and community support is vital to facilitate a positive child, family and future developmental outcomes. Early identification, special education intervention and language development is critical to optimise learning. Increased stimulation was associated with improved performance.

Executive Summary

Background: The Human Immunodeficiency Virus (HIV) pandemic and the rapid spread of the virus has had far reaching effects on families, communities and populations in many countries. The introduction of antiretroviral therapy has greatly reduced mortality and morbidity in children with HIV and as the prognosis improves due to the introduction of antiretroviral therapy, attention needs to be paid to the quality of life of these children and the optimizing of their functional ability. Due to the ill health or premature death of either one or both parents as a result of HIV/AIDS there has been an increase in the amount of orphans and an increased need for appropriate placement of these children. It is known that HIV results in delayed development but the factors that determine this delayed development are less well known. It remains to be established if the residential setting of orphaned or abandoned children, whether institutional or with foster parents has an impact on developmental delay.

Aim: The aim of the study was to compare the motor development of children aged 3-6 years with HIV/AIDS residing in institutions with similar children in foster care using the Peabody Motor Developmental Scale (PDMS II). A secondary aim was to compare the development of children with HIV to those who do not have HIV in these residential settings.

Objectives: The specific objectives include, in children three to six years of age living in either institutions or in foster care in Cape Town, with and without HIV:

1. To describe the living and socio-economic conditions of children living in foster care and institutions with regard to the following factors:
   - Age at which placed in foster care/institution and length of time in this setting
   - Demographic and economic characteristics of care-givers

- Description of the care giving environment with regard to stimulation of play and childhood development

2. To determine the health status of children who are HIV positive and to compare this across the different settings. Variables examined included:
   - Opportunistic infections and hospitalisations
   - Anti-retroviral therapy (ARVT)
   - Body mass index (BMI) standardized to age and gender
   - Access to health care and rehabilitation services

3. To establish and compare the developmental quotients of the children using the PDMS and compare the performance of children with and without HIV.

4. To establish and compare the developmental quotients of the children using the PDMS II and compare across the two care-giving environments.

5. To determine whether and to what extent the developmental quotient changes over a six month period and whether this change is associated with the different settings.

6. To establish which factors predict performance in the various settings.

Study Design: A descriptive, analytical, prospective, longitudinal study design was chosen and repeated observations were taken.

Participants: 44 children participated in the study. The children were recruited from four institutions in Cape Town and from community outreach programmes supporting foster parents.

Instrumentation: The PDMS II was used to assess and score motor development of all participants. A questionnaire was administered prior to data collection to

gather demographic and medical information and placement information. Height and weight were recorded using a tape measure and electronic scale and Body Mass Index was calculated and percentiles calculated using the Centre for Disease Control (CDC) norms.

Procedure: Data was collected from September 2006 to June 2007. Developmental assessments were conducted at baseline and six month later.

Data Analysis: All data was entered into and analysed using the Statistica Version 7 Software. Descriptive statistics were used to present frequencies and demographic data. Other tests used were Chi-squared test for associations between gender, HIV status and place of residence, the Mann-Whitney U test was used to test if there was a significant difference in the rank ordering of data that were not normally distributed. For numeric, normally distributed data, tested by using the Kolmorogov Smirnoff test, the independent t-test was used to determine if there was a significant difference in the mean scores of different groups. Dummy variables were created for residence and HIV status and multiple regression analysis was used to determine whether age, time on ARVT, residence and or status was predictive of the TMQ at baseline and at six months. Age and time on ARVT were found not to be significant so the model including residence and status was used. A .05 level of significance was used throughout the study.

Results: The sample consisted of 44 children, of which 25 resided in institutions and 19 in foster-care with a mean age of 52.75 months (SD = 10.88; Range = 35.7 – 73.8 months). Twenty one children had HIV. There was no difference in the distribution of gender or HIV status between the two residential settings. All the children were of black African or mixed descent. Six months later 37 children were tested.

All children who were HIV positive were on antiretroviral therapy and all children had been on treatment for five months or more. With regard to the BMI percentiles,

the HIV negative group scored significantly higher (75.8, SD=15) than the children with HIV (58.8, SD=31.4) however there was only one child with HIV who scored below the 5th percentile and was categorised as being underweight. No child was hospitalised during the period of study due to HIV related causes.

Children with HIV were found to be significantly delayed in all aspects of development, with a mean developmental quotient of 80 (SD=10.2) compared to 95.3 (SD=11.8) in non-affected children ($p<.001$). The difference was greatest in the Gross Motor Quotient (GMQ) where the mean difference was 18.3. The difference in means was 12.7 and 16.0 for the Fine Motor Quotient (FMQ) and Total Motor Quotients (TMQ) respectively. In children with HIV, the FMQ bordered on being statistically greater than the GMQ ($p=.08$). There was no difference in TMQ between males and females in the combined group ($p=.78$) and in the HIV positive group ($p=0.39$).

The score of children in foster care was 82.2 (SD=15.8) and this was significantly less than those in institutions (90.6, SD=10.6; $p=.04$). The difference between children with HIV in the two residential settings was greater (10, $p=.02$). The score on the second testing, six months later was significantly higher for both the HIV positive and HIV negative children in all areas of the PDMS II.

For the whole group, in addition to HIV status, place of residence emerged as a predictor of TMQ at baseline with children in foster homes scoring approximately 5 points (entire sample) or 13 points (HIV positive sample) lower than those in the institutions. Place of residence lost its predictive value at six months. In the children with HIV, in a model including place of residence, length of time on ARVT and age of commencement of ARVT only place of residence was predictive of TMQ. This remained true at six months.

Discussion and conclusions: The results of this study are encouraging in that children seem to be well cared for in both residential settings. The medical service

rendered to children with HIV is well managed in both settings and the children seem to be accessing regular ARVT. This is evident in the lack of hospitalisations and opportunistic diseases reported during this study. However, the children in foster care do not seem to have adequate access to rehabilitation services and this is an area of concern, particularly for those who are developmentally delayed.

In institutions, the amount of structured play and opportunities for stimulation are considerable as each institution has trained staff to run crèche facilities. In addition, there is the important contribution of international agencies placing volunteers who spend time playing and interacting with the children. In the community, the foster parents attend monthly support groups and training sessions run by Social Workers. In addition, over the course of the study, all children began to attend formal crèches.

However, the results of the PDMS II indicate that children in foster care, and particularly those with HIV, perform worse in the area of fine motor skills. The difference decreased over the course of the study, which implies that performance on the PDMS II is influenced by changes in the environment. This might indicate that the fostered children, especially those with HIV, need more stimulation and that this group need to be targeted in future. This need is also likely to be evident amongst children with HIV living with their natural parents, or being cared for by relatives as the socio-economic setting is most probably similar.

The results of the study indicate that HIV children are significantly delayed compared to their HIV negative counterparts, particularly with regard to gross motor function. However, all children with HIV received ARVT and appeared to be thriving with regard to their general health and BMI. However, the institution of ARVT was not found to mitigate against the developmental delay (at least up until six months after use). It would therefore appear that the developmental delay might be due to primary damage to the nervous system which might take place even before the onset of opportunistic infections. This delay seems to persist even when these infections are prevented by adequate medication. The possibility that

universal access to ARVT will not result in eradicating developmental delay needs to be researched further. It is suggested that developmental delay be regarded as a defining symptom of HIV and that, on its own, warrants the initiation of treatment. Early institution of ARVT might prevent or decrease this delay. However, if the delay cannot be prevented or treated with ARVT, then appropriate therapeutic intervention becomes essential.

Recommendations: It is difficult to cope with a chronic disease and therefore parental support, family and community support is vital to facilitate a positive child, family and future developmental outcomes.

- There should be a strengthening of the support programmes within the communities to ensure that all fostered children, particularly those with HIV, received adequate developmental stimulation.
- This programme should be made available to all children with HIV living in the community, not only those living in foster care.
- The results of this research may be used in the formulation of policy with regard to improving the infrastructure within deprived communities and those in areas where parents are classified within the low income bracket.

About one third of the children with HIV demonstrated considerable delay. As early identification of developmental problems is critical to optimizing learning, special education intervention and appropriate development of language, it is recommended that:

- A system that ensures adequate management be put in place to address medical, developmental and educational needs and monitor change over time. This should be supported by a well established referral system for effective management of children experiencing difficulties.
- Rehabilitation professionals should use standardized tests for the identification of delay in children at risk and for the monitoring of progress.

The PDMS II was found to be reliable, valid and easy to administer and it is suggested that it be used in future.

Although no causality was proved in the study, it appears that increased stimulation in the different settings was associated with improved performance. It is therefore recommended that specific intervention programmes, including stimulation of fine motor activity for children in foster care and gross motor activity for children with HIV be developed and instituted. NGO's should be encouraged to recruit volunteers to work with foster parents and their children, as well as with the institutionalized children.

The implication of the number of children with developmental delay is that the prevalence of developmental delay is high in this cohort of children and as more children begin to access the educational system, educators need to be aware of the possibility of special educational needs of the learners.

The study also identified areas in which further research is required. It is recommended that the following areas need to be studied further.

- The long term impact of ARVT needs to be established by means of a large, longitudinal study. Similarly, the optimal stage and age at which this should be initiated needs to be established.
- Future research is recommended to identify and establish appropriate methods of rehabilitation service delivery in the various communities.
- The impact of care settings and HIV status on the school performance of children will need to be examined. In addition the impact of development motor development on schooling also needs to be established. While children are admitted to institutions and foster care at a vulnerable age, it is important that these issues are considered when children start their schooling career.

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List of Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ARVT	Antiretroviral Therapy
BMI	Body Mass Index
BSID	Bayley Scales of Infant Development
CDC	Centres for Disease Control and Prevention
CNS	Central Nervous System
FAS	Foetal Alcohol Syndrome
FCG	Foster Care Grant
FMF	Fine Motor Function
GMF	Gross Motor Function
GSH	Groote Schuur Hospital
ARVT	Highly Active Antiretroviral Therapy
HIV	Human Immunodeficiency Virus
ICF	International Classification of Functioning, Disability and Health
MTCT	Mother to Child Transmission
NGO	Non-government organization
PDMS II	Peabody Developmental Motor Scales – Second Edition
RXH	Red Cross Children's Hospital
SA	South African
SES	Socio-economic Status
TB	Tuberculosis
WHO	World Health Organisation

List of Appendices

1. Introduction

1.1. Background to study

The HIV/AIDS pandemic has hit the children of sub-Saharan Africa hard. Documented reports show that while less than 8% of the world's population occupies Sub-Saharan Africa, it is estimated that about two thirds of global AIDS cases, including adults and children, is included within this population [1].

In 2002 there were approximately 28-30 million adults and children infected with the Human Immunodeficiency Virus (HIV) [2 3]. During the course of that year, a further 3.4 million people became infected with the virus in Africa and around 700,000 cases alone were children under the age of 15 [2]. By the end of 2003, 2.5 million children globally and 2.2 million in Africa were living with HIV [4 5]. It is estimated that there are more than 1600 children are being infected each day with most of these infections occurring in Sub-Saharan Africa [6].

In Africa and the Caribbean, AIDS is the leading cause of death in children under 5 years [7]. Forty-five percent of children infected with HIV and rapidly developing AIDS are dying within their first two years of life. [2]. Globally, by 2003, 15 million children under the age of 18 years were orphaned by AIDS and these children were in the care of foster parents (35%), in institutions (0.25%), living on the streets or living with other family members (65%) [5 8 9]. In 2005 it was estimated that there were 2.5 million orphans in South Africa alone [9]. By 2015 it is estimated that about 4 million children (10% of South African population) will be orphaned [9] and the extended family system will find it increasing difficult to absorb these orphans due to continued severe economic constraints [10].

It is clear that the epidemic represents a crisis of major proportions and is causing and will in future cause great social disruption of families and society [6]. In many African countries, a large percentage of the general population has limited access to essential resources and it has been well documented that a large percentage of the AIDS population comes from low socio-economic areas with even less access to resources [5]. Similarly, within the South African context, the majority of children infected and affected by HIV/AIDS are drawn from already disadvantaged communities [5].

The growth in the amount of orphaned or abandoned children from deprived socio-economic situations has increased the need for appropriate placement which would allow them to be cared for in safety and grant them access to essential services such as education, health care and social welfare. Various types of care settings have been established in different communities in order to alleviate the plight of these vulnerable children [11]. These include foster care (with a relative or non-relative), institutionalisation and adoption. Each of these settings may have positive and negative impacts on the development of these children.

In South Africa it is estimated that about 29 000 children are cared for in 169 registered children's homes and 37 places of safety and many residential homes have now opened their doors to house children affected and infected by HIV/ AIDS [12].

1.2. Effect of institutionalisation on child development

The culture of institutionalisation has been reported to be primarily concerned with the physical care of the residents and the establishment of a routine rather than with providing stimulation and interaction for the development of the children [13]. The children's lives, emotions and behaviours have all been said to centre on the routine

that exists within the institution and feeding, bathing and playing are planned around staff and the schedule within the institution.

While research suggests that institutions contribute to a large extent to global developmental delay of the children it houses, other studies have also shown that many institutions/ orphanages provide an improved environment than that from which the children come, in terms of e.g. regular meals and full-time shelter. However, these institutions/orphanages may not be able to / do not provide the individualized nurturing found in loving and responsible families and households [14]. The caregiver to child ratio, which varies across institutions, may also be limited and thus contribute to a delay in emotional and behavioural development [15 16].

According to articles retrieved from the Reconciliation and Social Justice Library of South Africa, various expert opinions on the effects of institutionalisation noted that children who had been institutionalized displayed abnormalities in development of behaviour, motor developmental delay, learning difficulties, psychological and emotional distress [14 16 17]. There may be a limited amount of positive reinforcement of good behaviour and as a means of coping, the children may become passive when distressed. Speech and language development may be delayed due to lack of appropriate responses from staff. Lack of physical and social stimulation within the institution may lead to a decline in psychological development along with delayed motor development and behaviour [17].

1.3. Effect of fostering on child development

It is stressful for any child when the decision is made to place him/ her into foster care. Up to 30% of children placed in foster care may suffer from some form of emotional, behavioural or developmental difficulties [18]. Foster children may perform significantly worse in school than other children. This is attributed to possible physical and emotional trauma due to a loss of parents, to HIV/AIDS,

living with and caring for parents or family members who are ill or dying, stigma attached to being orphaned as a result of AIDS and separation from birth parents. Changes in foster care placements, exposure to alcoholism, drug abuse, possible neglect and abandonment are all factors which may impact on the physical, emotional and behavioural development of these children with the subsequent interference with learning [10 18 19].

Grandparents contribute significantly to the foster care system, and as they may be economically deprived and lack knowledge regarding proper nutrition and adequate modern health care, children may be malnourished causing developmental and emotional delay [10]. On the other hand, there is literature which suggests that when children are fostered at a young age, and this occurs as a result of 'voluntary fostering', they tend to flourish and fare better in the foster home due to improved living conditions [10].

1.4. Effect of HIV on Development

The influence of HIV on development has been well documented. The HIV infects the developing Central Nervous System (CNS) of children and the virus is known to enter the CNS early in the course of the disease [3 20]. Both motor and cognitive development is affected, and neurological manifestations range from being static (non-progressive developmental delay) to progressive encephalopathy (acquired microcephaly, pyramidal tract signs and spasticity) [20 21]. Younger children with AIDS develop a progressive encephalopathy and present with a delay in motor milestones while the loss of higher cortical function occurs in older children [22 23]. Delay is present even after the initiation of anti-retroviral therapy (ARVT) and even without the influence of opportunistic infections, motor performance has been found to be at about 75% of that of typically developing children[24].

1.5. Aims and Objectives of the project

1.5.1. Aims

The aim of the study was to compare the motor development of children aged 3-6 years with HIV/AIDS residing in institutions with similar children in foster care using the Peabody Motor Developmental Scale (PDMS II). A secondary aim was to compare the development of children with HIV to those who do not have HIV in these residential settings.

1.5.2. Objectives

The specific objectives include, in children aged three to six years of age living in either institutions or in foster care in Cape Town, with and without HIV:

1. To describe the living and socio-economic conditions of children living in foster care and institutions with regard to the following factors:
   - Age at which placed in foster care/institution and length of time in this setting
   - Demographic and economic characteristics of care-givers
   - Description of the care giving environment with regard to stimulation of play and childhood development

2. To determine the health status of children who are HIV positive and to compare this across the different settings. Variables examined included:
   - Opportunistic infections and hospitalisations
   - Anti-retroviral therapy (ARVT)
   - Body mass index (BMI) standardized to age and gender
   - Access to health care and rehabilitation services

3. To establish and compare the developmental quotients of the HIV positive and HIV negative children using the PDMS II.

4. To establish and compare the developmental quotients of the HIV positive and HIV negative children using the PDMS II in institutions and in foster care.

5. To determine whether and to what extent the developmental quotient of the HIV negative and HIV positive children changes over a six month period and whether this change is associated with the different settings.

6. To establish which factors predict performance in the various settings.

1.6. Significance of study

As indicated above, there are large numbers of children who have been orphaned as a result of losing parents to HIV or other conditions in the Western Cape. It is of paramount importance that these orphaned children are placed in an environment that is caring, safe and ultimately offers long-term stability. The response of the authorities is to either place these children in institutions, orphanages, or to try to find suitable foster parents. Each of these situations may have advantages and disadvantages for the child, e.g. improved nutrition within an institutional setting compared to more individual attention in the foster care setting.

1.6.1. Policy development

Children with HIV, who have lost their parents, are at an added disadvantage in that institutionalisation or foster care and the presence of the HIV have both been found to delay normal development. Research regarding the development of children within these two settings might provide information which could contribute to the development of policies regarding the placement of these children.

It is hoped that the Department of Health in collaboration with the Department of Social Services and community programmes will find information generated by this project useful in developing appropriate support networks and programmes to benefit children in foster care and children in institutions who may not have access to essential therapeutic services.

1.6.2. Intervention and monitoring

It is necessary that the motor development of children with HIV/AIDS is continuously monitored. Information gained from this study could be used to educate health care professionals, educators and other service providers with regard to early identification of potential problems within their area of service provision. Physiotherapists would be alerted to the need to detect early delays in motor skill development and would be able to provide caregivers, schools and staff at institutions appropriate advice regarding early intervention programmes.

1.6.3. Physiotherapy and the AIDS Pandemic/Epidemic

Physiotherapists need to have an understanding of the natural history of the virus, the consequences of infection and the presenting signs and symptoms as they exist as a result of the virus. The multidisciplinary/holistic approach to the treatment of children affected and infected by the HIV/AIDS virus underscores the need for physiotherapists to broaden their knowledge in order to effectively and efficiently manage their clients/patients and educate and counsel their patients as well as protect themselves from infection.

The increase in the prevalence of HIV infected individuals, the introduction of antiretroviral therapy and the large government roll-out programme instituted in April 2004 has seen a large number of individuals (adults and children) living longer. More people are gaining access to ARVT and we can expect to see the transition from an acute, terminal disease to a chronic disease [25]. The effects of the

virus have necessitated the holistic management of individuals and therefore the need for rehabilitative services and thus the role of the physiotherapists in acute, rehabilitative and educational settings [26].

Physiotherapy is a valuable component of the multidisciplinary approach to the management of those living with HIV infection [26 27]. Physiotherapists are involved at various levels/stages in the treatment with children with HIV. These areas include chest physiotherapy for those with chronic lung disease, active rehabilitation to improve lung function and overall endurance of individuals and treatment of developmental delay in children whether mild or severe.

It was anticipated that this study would assist in further defining the role of the physiotherapist in the management of children affected and infected by HIV.

1.7. Research Setting

The research was undertaken in institutions housing children within the Western Cape; and in communities in which children who are being cared for by foster parents. Foster care agencies and community outreach programmes were selected as areas to gain access to children who had been fostered primarily as a result of HIV/AIDS. The children who were fostered were all tested prior to placement with foster parents and those in the institutions were tested as well.

The Children's Court is the guardian of all children and there are specific guidelines set out by the Department of Social Development i.e. National Guidelines for Social Services to children infected and affected by HIV/AIDS [11]. Included in this document are guidelines that pertain to the placement of orphaned or abandoned children in foster care, a place of safety or an institution.

Once a child's home circumstances are investigated, and a child is thought to be in need of care, the following steps need to be taken [11]:

- The Social Worker must write a report to the Commissioner of Child Welfare
- He/She must investigate options for placement
- A court order is received in terms of the Child Care Act whereby all children are protected by the law
- The Social Worker investigates the foster parent/s and family and home circumstances
- If the interest is there to foster a child, the court order allows the interested parties to care for the child

The following institutions and organizations are a few of the care placements caring for these children in the Western Cape. The names of the institutions and foster care agencies have been withheld for reasons of confidentiality. For this purpose, these placements have been named Institution A, B, C, and D.

1.7.1. Organisation A

The organisation is a child-fostering project operating in the Khayelitsha Township in Cape Town at grassroots level. Due to the large percentage of people infected and living with HIV/AIDS, community meetings were held in 2000 to discuss what could be done to help the huge numbers of orphans being created as a result of HIV/AIDS. The project started with 40 foster children in care and now there are 100 orphaned children. It is a non-government organization (NGO) with private funding.

The primary aim of the project is to support families affected by HIV/AIDS and to ensure that orphans are placed in secure, stable and nurturing homes, preferably within their extended family or their own community. Psychosocial support is a major component of the programme - the practical and emotional concerns cannot

In developing countries, it has been found that diagnosis of the paediatric population is often difficult for many health care workers as the presentation of the HIV disease in this population group are non specific and frontline health care workers and first contact practitioners may lack algorithms [2]. Not all children are tested, due to expense or parental unwillingness in Cape Town / South Africa. It is not always possible to know whether a child has been infected with the virus as a large percentage of children present with infectious diseases commonly found in positive children but these manifest in developing countries/communities as a result of poverty, malnutrition etc [2].

Children may be classified according to the rate at which disease progression occurs. Infants infected perinatally are known to progress to AIDS more rapidly than those persons infected through transfusions or sexual contact [21]. Rapid progressors develop serious signs and symptoms between 12-24 months of age, with a rapid loss of cells that regulates the immune system in combating certain viruses i.e. CD4 cells. These account for up to 20% of the children [23]. A second group of children fall into the category of slower progressors, where severe compromise of the immune system occurs around 7-8 years and their CD4 cell loss occurs at a rate more gradual than the rapid progressors. A small group of children remain healthy until 9-10 years of age. There is minimal loss of CD4 cells with minimal or no symptoms of HIV disease [23].

2.4. Signs and symptoms of the disease

2.4.1. Neurological complications of the disease

A range of neurological complications may be present. These complications vary from mild to severe. During early years of brain development, neuronal loss and demyelination occur in children with HIV as a result of direct infection [32-34]. International studies have documented significant CNS involvement and serious neurological signs and symptoms of cognitive and motor delays occur early in life.

These may progress rapidly until the age of two and a half years. Along with Central Nervous System involvement, a delay in neurodevelopmental milestones is often the first presenting symptom [35 36] and this has been seen as an early indicator of HIV disease progression [32 37]. Children may be slow in reaching developmental milestones and the acquisition of motor and mental skills is frequently delayed [21 23].

The developing brains of children with HIV that are infected via vertical transmission are more vulnerable to neurological manifestations and the effects of the virus. The neurological complication most commonly occurring in children with HIV infection is encephalopathy, where demyelination affects the projection of fibres and commissural connections causing global motor delay. Less frequently occurring complications include cerebrovascular disease, spinocerebellar dysfunction, peripheral nervous system disorders and neoplasia [33]. Other studies have shown that neurological signs may range from mild forms of developmental delay to spastic paresis to severe cases of severe spastic quadriplegics. Seizures have been reported in 13% of children with HIV-1 infection [33].

With the initiation of ARVT, complications are less severe and less common [33]. Access to ARVT may not eradicate neurological complications but it may increase the chances of survival with more subtle neurological involvement.

2.4.2. Effects on growth and height

Children with HIV may demonstrate wasting and stunting [1 38] Wasting is also included on the list as one of the principal criteria for diagnosing symptomatic AIDS and as such is defined by the Centres for Disease Control and Prevention [38] is the "persistent weight loss of more than 10% of baseline, downward crossing of more than two percentile lines on the weight-for-age chart in a child aged one year or older, or less than the 5th percentile on the weight-for-height chart on two consecutive measurements at least 30 days apart plus chronic diarrhea or documented fever for at least 30 days, whether intermittent or constant." [38].

In South Africa up to 60% of all childhood hospital admissions are related to HIV infection [33]. Clinical symptoms identified in children with HIV include recurrent diarrhea, enlarged lymph nodes, recurrent bacterial infections of the upper respiratory tracts, ears and sinuses, atopic dermatitis, parotitis, hepato and splenomegaly. As disease progression occurs, other clinical symptoms have been identified. These include bacterial pneumonia, recurrent diarrhea, lymphocytic interstitial pneumonia, sepsis, gastro intestinal candidiasis, cerebrospinal meningitis, herpes simplex and Varicellar Zoster [31].

Severe OI may also present and the ones most commonly occurring include Mycobacterium Tuberculosis (TBC), disseminated Mycobacterium Avium Complex (MAC) Pneumocystitis Carinii (PCP), Cryptococcosis, Oesophageal candidiasis and less frequently Cytomegalovirus (CMV) [30 31]. A general decline in opportunistic infections and subsequently hospitalisation of children occurred as the availability of ARVT for children increased after 1995 [30]. At this stage ARVT had a greater impact in the developed world while the majority of children in developing countries did not have access to this treatment. Up until 2000 in South Africa recurrent hospitalisation of infected children continued with the common reasons for admission to hospital including infection such as gastro-enteritis, pneumonia and malnutrition [10].

2.4.4. Developmental delay

A large number of studies have shown that 30% - 40% of children infected with the HIV virus will present with developmental delay. One such study, conducted in South Africa, authors found that 40% of children infected with HIV presented with developmental delay [28]. Neurologic complications are described in 20%-60% of published articles and mostly related to HIV-1 encephalopathy. Those children infected with the HIV virus and who survive beyond the first year of life can present with a wide variety of neurologic complications [20].

Various factors during pregnancy and postnatally (within the first 2 years of life) have been identified by many researchers as the cause of psychomotor and motor delay. Factors include stress during pregnancy, home environment, maternal educational level, stimulation of the child at various stages of their development [34] [40] [41]. The influence of these factors is discussed below.

2.5. Intervention

2.5.1. *Treatment with Anti-retroviral Therapy (ARVT)*

In 1995-6 ARVT was made available to those who were infected with HIV/AIDS and prophylactic medication introduced for the prevention of AIDS related opportunistic infections. This was limited to developed countries and those who could afford the medication [30].

The introduction and use of antiretroviral treatment (ARVT) has greatly reduced mortality and morbidity in adults and children [3] [29] [42]. In the United States and other developed countries, developments in treatments and scientific advances such as triple drug treatments have evolved. This potent three drug combinations of the HIV drugs is known as highly active antiretroviral therapy (ARVT) [43] and it is effective in maintaining immunological function [44]. Quality of life and prognosis of the HIV positive paediatric population has improved. Children respond well to aggressive, multidrug antiretroviral regimens as their cellular responses appear to be similar to that of adults [29] [45]. Along with improved treatments in developed countries, these children live longer and have improved function over a greater number of years [3] [20] [46].

Approximately 65% of the infected paediatric population in the developed world now lives past the age of 5 years as a result of advances in treatment regimes and the improvement in therapies [25]. Antiretroviral therapies are not available in a number of areas in developing countries as the costs of these treatments are

exorbitant. It is not affordable for up to 95% of the infected adults and children in developing countries [5 29].

The South African government commenced the antiretroviral roll-out plan in March/April 2004. More adults and children are now gaining access to ARVT; however, eligibility needs to be assessed prior to commencement of the medication. Since the roll-out programme started, provision at various public hospitals i.e. Red Cross Children's Hospital has become a priority with referral to and support of community clinics. Children in South Africa are only eligible to receive ARVT on the government programme if their CD4 counts are less than 15% of normal (Department of Health, 2003).

Once the rigorous introduction of aggressive combination therapy on the CNS occurs, there is an overall decrease in the viral burden. Multidrug therapy has gained tremendous ground. Children currently on a course of combination antiretroviral therapy may achieve levels of protective antibodies as drugs act to suppress plasma HIV concentrations to below detectable levels [29]. Effective and efficient delivery of joint services among health care professionals and policy makers should improve and strengthen current screening and implementation programmes with regard to children in South Africa.

2.5.2. Screening and the influence of ill health

There is a great shortage of staff at public hospitals and community health care centres which has precluded the service from screening every child for "subtle" neurologic complications. Developmental screening in children is a very important process in conjunction with medical screening in children who are HIV positive. Children are living longer and as HIV/AIDS is no longer an acute, terminal disease, children are presenting with varying degrees of developmental delay [47]. Currently, children being assessed in the neurology service at Red Cross Hospital generally have been identified with more extreme neurologic complications.

Illness and hospitalisation could also have a negative impact on the normal developmental progress of a child. A study conducted in 2000 reviewed the prevalence of admissions of paediatric patients to hospital in Soweto [48]. A significant burden was placed on health services, and it was found that the most common causes for admission to hospital for these children (HIV group) were diseases like pneumonia and gastro-enteritis. Prolonged and frequent hospitalisations also cause physical and emotional distress to the children being admitted with the most vulnerable being aged six months – four years [48].

Infants most delayed were delayed with activities requiring proximal muscle strength as well as co-ordination of movement. Potterton and Eales were not however, able to conclude whether it was due to muscle weakness and the effects of the chronic illness or a result of the inco-ordination of muscle activity due to a CNS deficit [28].

The occurrence and manifestation of HIV in adults and children has completely changed the medical and rehabilitative management of patients in South Africa. A shift in the pattern of the disease has led professionals to recognize it as a chronic illness rather than one that is an acute, terminal/deadly disease [25 29 42].
Globally, HIV disease presents a huge challenge with regard to the management and prevention of child mortality and thus promotion of child health [29].

2.6. *Factors relating to development*

2.6.1. Effect of environment

The first two years of a child's life are extremely important as most of development and brain growth occurs during this period, and with this there is a surge of motor and mental development [32 33]. There has been much debate around the role that the environment plays in development. Theories have been formulated with which range from the maturationist (development occurs as a result of biological processes that occur automatically in a predictive and sequential manner over time) to the

environmentalist (the environment shapes the individuals learning and behaviour.) Research dating back to 1976 emphasizes the importance of early stimulation of a child for the development of motor and cognitive skills [49].

It is now generally held that children learn new skills in response to their environment and by reacting to their surroundings [50]. The role of the environment is increasingly accepted as being the key to development.

The development and maturation of the human brain occurs rapidly and there is a large amount of synapses and neurons in the infant's brain that are constantly being formed. As mentioned, this adaptation of the infant's brain occurs in response to the environment in which the infant interacts (neuroplasticity) [32 33]. Therefore, for normal development and maturation of the brain to occur, interaction with a responsive environment must occur. Early experiences determine which neural pathways are to be utilized or discarded. The infant needs to interact with a living, responsive environment for brain development and maturation to occur [32 33]. A sensitive caregiver and a secure attachment promote brain growth and development while an impoverished environment has the opposite effect and suppresses brain development.

Brain function may be adversely affected in the early years of life as a result of neglect and abuse while a stimulating environment and a sensitive caregiver facilitate brain growth [51].

Emotional stimulation or lack thereof including maternal verbal and emotional responses, whether they provide the appropriate toys for play and involvement with the child may all contribute negatively or positively to the development of children [49]. Language development specifically was found to have a strong association with the mother's educational level and stability of the family within the home environment. Developmental milestones were also correlated with family stability. A study conducted in Brazil found that while healthy children develop in a certain manner, children's environment may impact negatively on healthy children. Certain

factors including absence of a father, improper toys at various ages, poor socio-economic circumstances and an environment where the child was kept at a young age, all may impact negatively on a child's health [50]. Children restricted from moving freely during the day were greatly compromised with the process of learning suffering, using the feedback and feed forward mechanisms which are vital for motor skill acquisition [50].

Factors such as low socio-economic status, poor stimulation, along with a poor home environment all play a role in contributing negatively to the overall development of the child, ill-health of child and parents/caregivers of the child, [47]. The child's ability to explore their environments in impoverished areas is often limited as the area around informal housing may not be conducive to play. Developmental milestones were also correlated with family stability. Single mothers/single parents have more responsibility within the household and with the care and well-being of their children, thus spending limited time and interaction with their offspring and limiting development [34].

2.6.2. The impact of cultural practices on development

Anthropologists have pointed out that many cultures exist within one society and that distinctive cultural attributes are evident in various cultural groupings. In South Africa, with such diverse cultures existing within its borders, child rearing practices and attitudes across various cultures should be considered when assessing the impact on child development.

The importance of achieving different developmental milestones at various ages is primarily a Western idea of development [52] and the importance of specific milestones for caregivers across African and Western cultures may differ considerably [53]. According to Richter and Grieve, regardless of one's cultural practices, the way the mother stimulates her child, arranges the environment and interacts with the child have important implications for cognitive and motor

development [54]. Abbott and Bartlet have examined cross cultural studies and have drawn contradicting conclusions [53] similarly state that parental expectations and cultural care giving practices appear to play an important role in motor development.

2.7. *The orphan crisis and government response*

The population group most affected by HIV in a large number of African countries e.g. Botswana, Lesotho, South Africa and Zimbabwe, has been women. With an increase in maternal HIV/AIDS [2] there is an increase in the number of mother-to-child transmission (MTCT) cases (vertical transmission). According to UNAIDS, WHO, children orphaned due to HIV are defined as those children under the age of 15 years that have lost either one or both parents [1]. They may be classified according to maternal (loss of a mother), paternal (loss of a father) or double orphans (loss of both parents). In 2004, UNAIDS changed the definition of an orphan to a child below the age of 18 years who has lost either one or both parents [9]. By 1999, it was estimated that there were 13 million children infected and affected by AIDS globally [1], of these, the great majority (12 million) were in Sub Saharan Africa[1]. By 2003, 15 million children under the age of 18 years were orphaned by AIDS and these children are currently in the care of foster parents (35%), in institutions (0.25%), living on the streets or living with other family members (65%) [5 8 9]. It is projected that by 2010 the orphan crisis will reach insurmountable heights of 35 million [55].

2.7.1 HIV/AIDS policy and strategic plans

In South Africa, a national strategic framework is in place for children infected and affected by HIV/AIDS [6]. It is geared towards these vulnerable children and aims to ensure that they have access to nutrition, shelter, education, health care, family alternative care and protection from abuse and mistreatment. A key issue in any response to the orphan crisis is to establish safe living spaces for children.

The government has introduced various grants for primary caregivers to support those orphaned and vulnerable as a result of HIV/AIDS. These vary from R170 (Child Care Grant) to R530 (Foster Care Grant) [11]. Of the six countries studied in the Audit of HIV/AIDS Policies [16], only South Africa and Botswana had a policy for orphans [6]. Botswana has a national policy for orphans and vulnerable children where the aim is to provide food, uniforms, and other necessities to assist caregivers with the impact of HIV/AIDS on the family's income. Education is free for all children including orphans.

2.7.2. Need for psychosocial support

"Psychosocial Support is defined as an ongoing process of meeting physical, emotional, social, mental and spiritual needs of orphans and vulnerable children". These are all considered to be essential elements for a meaningful and positive human development" [55].

Loss of love and care by the loss of either one or both parent/s has a tremendous impact on the child. Loss of security and safety within their own environment, motivation, trust, confidence in the family unit, poor socialization within their communities, loss of identity all may impact on the child who has lost parent [55]. Many children may suffer the loss of more than one parent or other relatives over a period of time, suffer poverty and the change of households, stigma attached to being either an orphan or a child of an HIV infected parent and the lack of a stable, secure family life [2 10]. In a study in Uganda, children were found to be fearful of the death of a parent and felt hopeless and angry when parents became ill. The rate of depression was also high amongst orphans [2].

In a study conducted in Dar-es-Salaam, the role of traditional healers in caring for orphans has been identified and along with providing these orphans with the basic needs of food, clothing, shelter, they stress the importance of culture in achieving emotional, psychological and physical needs support by those caring for them. The

importance of being trained in dealing with the above issues is also stressed to allow better coping mechanisms for the orphans in their newly acquired environments [55].

2.7.3. Institutionalization

Unfortunately community based care within a caring, culturally appropriate environment is not often possible and children need to be cared for in institutions. According to literature reviewed, institutionalization is strongly not favoured as it is unable to mimic a good, loving home environment and is an expensive option to care for these children. Children infected with HIV/AIDS place an added stress on these institutions, as they are now requiring extra health care at the expense of the institution and the government making it more expensive to recruit specialist staff to provide adequate care for these children.
Early global deprivation of institutionalized children may result in persistent specific cognitive, behavioural and motor deficits. Separation from the primary caregiver affects a range of skills and these may be temporary or permanently depressed. A study conducted on post-institutionalized children in Romanian orphanages found that dysfunction of certain brain regions occurred which may have resulted from stress of the early deprivation [15-17 56 57].

Many orphanages may provide a better environment than the circumstances under which children live with biological parents/ families. However, these orphanages may not be able to / do not provide the individualized nurturing found in loving and responsible families and households [14].

In Zimbabwe, with the increase in the HIV/AIDS orphans, community care centres for the care of these orphans were evaluated. Community based care was advocated, however, in South Africa with the increase in orphans, families are finding it increasingly difficult financially and emotionally to care for foster children along with their own families [10].

Children develop and grow through experience. They regulate their behaviours and emotions in response to cues from caregivers. Most of the development occurs within the first 3 years of life and occurs as a result of the interaction with a responsive environment [58]. In a loving, family environment, children are comfortable to explore and emotional bonds are formed with family members / caregivers. They are consistent through everyday life compared to the variety of staff in institutions and a change in staff rotations [8].

2.7.4. Foster care

Foster care is the care of a child of another parent. According to the Department of Social Development, national guidelines for social services exist for the care of children infected and affected by HIV/AIDS [11]. Various types of care are outlined and it includes foster care. The child may be a member of the extended family (a relative) or a child unknown to the carer (a stranger) [11]. The South African Government provides a Foster Care Grant (FCG) to any person who has fostered a child. The primary caregiver is entitled to this grant which amounts to between R470 – R530 per month, per child being fostered. Any person over the age of 18 years is allowed to foster a child. These adults need to be secure, stable, free of crime, drugs and alcohol abuse and the abuse of children [11]. A foster parent may have up to 10 children in foster care at any given time. Each of these children is entitled to the FCG. The amount of the FCG may vary each year.

Cultural differences and norms regarding child rearing should be considered especially in Africa and in the African culture. In African culture parental role-sharing has occurred for many years i.e. a child belongs to a large family and the care and discipline of children are communal responsibilities [59]. Continued care of children is therefore ensured if parents die or are unable to adequately care for them. Breakdown of the extended family system has been blamed on apartheid, poverty, a migrant labour system and this had placed families under added stress.

Various studies suggest that the extended family support has slowly eroded as a result of apartheid [10 59].

In Kenya, with the introduction of "Christianity, a western culture and modernization", state foster care has taken over from traditional foster care. The Kenyan constitution calls for foster parents to be decided by the courts to protect children from neglect, abuse or denial of basic necessities rather than foster care within extended families. This has certain implications as parents are unable to foster children due to the lack of resources and large families [60]. While this can be understood as various studies in literature have described the unequal treatment of foster parent [10], the protection of children is also vital.

Due to the rise in the amount of children affected and infected with HIV/AIDS, the South African Government may find it extremely difficult to cope with these large numbers if various communities refuse to care for these orphaned children. In turn for community responsibility the government should provide support services in various communities in order for them to cope adequately [61].

2.8 The environment in which fostering takes place in South Africa

2.8.1. Breakdown of the extended family

The South African population has enjoyed 13 years of political freedom and democracy within South Africa. However, the past regime and political instability in the country has significantly contributed to the development of socio-economic difficulties among certain population groups especially the black communities, largely due to poverty. Social class distinctions have emerged and there has been a breakdown of the family support systems and structures such as the extended family support [10].

With the introduction of apartheid and the black migrant labour system, families were severely disrupted when the males were forced to leave their families in search of employment opportunities elsewhere [10]. It was with this disruption that the extended family fostering originated and strengthened to maintain family ties and care for children whose parents were forced to migrate. Thus informal fostering existed for many years and children mostly stayed with grandparents. Various studies concluded that the general system of foster care would only improve once apartheid was eradicated. Thus, 16 years on, formal fostering has increased tremendously and the patterns of foster care have changed [10] in part as a result of the AIDS pandemic.

Two type of fostering has been described in literature[10]. This included "voluntary" – where foster parents and biological parents have a special arrangement regarding their child rearing practices and "crisis-led fostering" – occurs during a time of death or economic hardship of biological parents and may be the case as described by the large number of children orphaned as a result of AIDS in South Africa. This is ultimately viewed as the social responsibility of extended family and communities [10].

An advantage of the extended family fostering system could be seen that it assisted development of community togetherness and sometimes even strengthened communities in terms of improving education of children, domestic labour and training; however, with the rapid spread of the HIV/AIDS disease it has changed the focus of the kinship/extended family care [10 62].

Many factors have contributed to poverty amongst various communities and thus the overall economic impact on households in South Africa

2.8.2. *Effects of educational status/level on child poverty as a result of apartheid*

The legacy of apartheid lives on. The townships were created a substantial distance from the city centre and were created for black and coloured communities, while the white minority lived in the city centre and in certain suburban districts [62 63]. The subsequent educational provision for various groups were distinctly different with the white minority being well-educated and thus able to secure well paying jobs. In contrast, their black counterparts lacked formal education, men were forced into the migrant labour system and women into domestic employment and were less likely to receive an income to support the entire family comfortably. The educational level of the head of a household is considered to strongly to predict child poverty and that the apartheid system has largely contributed to child poverty in South Africa [62 63].

The impact of poverty on many South African households runs deep and greatly affects the maternal and child interactions. Past policies in South Africa had the greatest impact on black communities with regard to poor/limited access to work opportunities, limited access to health care services and poor environmental conditions with regard to overcrowding, informal housing settlements, limited educational facilities and the forced removal (dispossession) of land and cattle [62].

2.8.3. *Impact of HIV/AIDS on child poverty*

Many surveys have been conducted which have found that socio-economic status decreases once an adult has HIV in the home environment [1 2 9]. This results in the decreased ability of one or both parents to continue working and along with the decline in income for these households, children are adversely affected. In single parent homes, children are faced with the responsibility of caring for a sick parent.

Limited financial resources are available and it is the responsibility of the head of the household to decide what is spent. Spending on school education and nutrition

decreases, the general well-being of family life declines while increased spending occurs on the health care of those infected [1 2 6 10]. In view of this, households, the public and private sectors are all adversely affected.
The vulnerability to long term physical, cognitive and emotional well-being is severely compromised [1] for these children who are infected and affected by AIDS.

2.8.4. Poverty and nutrition

In many African countries, a large percentage of the general population has limited access to essential resources [5 9]. In South Africa, it has been documented that a large percentage of the AIDS population comes from low socio-economic areas and that the group at higher risk of contracting the disease is black [5 9]. The immune system of children affected and infected with HIV/AIDS is already weakened and malnutrition is a common complication of the virus [38 64]. It may be particularly devastating for children who are growing and developing. High energy demands are placed on an already weakened system and the impact of inadequate nutrition is wasting and stunting [1 38 64]. Malnutrition in children with HIV/AIDS may not be purely as a result of the lack of food [2]. They may lack adequate nutrition as one or both parents are ill or have died as a result of HIV/AIDS, households are headed by children and orphans are fostered by grandparents or cared for by older siblings [38]. Households may be subject to economic hardship due to the death or migration of the primary breadwinner.

Studies worldwide have documented potential nutritional problems and the consequences in children with HIV/AIDS [1 2 9 38].

In conclusion, it can be seen that the HIV pandemic has the greatest impact on those communities which have the least financial resources to deal with illness and death. The tradition of fostering has been unable to cope with the increased numbers of children in need of care, both because of the poverty of the extended family members and the likelihood that HIV has affected potential care-givers.

Institutionalisation, although not a favoured option, might be preferred to care given in impoverished home.

2.9 Conclusion to the review

From the review of the literature it emerges that the HIV/AIDS pandemic is severe and has grave consequences for children, both in terms of their own health status and the loss of parents to the disease. It is well documented that HIV gives rise to developmental delay in children and that environmental factors can influence development. As the response to the need for safe shelter for orphans and vulnerable children, the South African Government has a policy of placing abandoned or orphaned children in foster homes as far as possible. Due to the poverty in the areas from which the children come and the breakdown in the extended family, it is difficult to place all children in foster homes. Many children are still institutionalized. The question arises as to the impact of place of residence on the development of the children.

3 Methodology

The following section focuses on the research design used, the sample size and recruitment of subjects into the study and the inclusion and exclusion criteria for particular groups identified in the study.
The instrumentation used during testing of subjects, and the procedure followed during testing is also discussed.
The pilot study conducted prior to testing, data collection, recruitment and assessment of subjects and the ethical considerations necessary when conducting the research follows in discussion.

3.1 Hypothesis

There will be no significant difference in the neurodevelopmental progress of children aged three to six years between the following groups:

- Children living with HIV and those without HIV in both institutions and in foster care.
- Children living with HIV in institutions and in foster care.

3.2 Research Design

A descriptive, prospective, analytical repeated measure study design was used to test the null hypotheses.

A descriptive design was chosen as there was no manipulation of variables and as the variable of interest, development, was anticipated to change over time, a longitudinal study was chosen. Longitudinal studies allow the repeated observations of individuals over time and because personal characteristics tend to remain

constant for the duration of the study, the differences observed over time may be interpreted as changes in development [65 66]. Repeated measures of performance may be used to confirm poor performance over time or track improvements in performance. However, attrition in longitudinal studies leads to a decrease in the number of participants and thus a decrease in the sample size [67].

3.3 Subjects

A sample of convenience was identified across all groups identified as part of the study. Participants were selected from foster care agencies and institutions in the Khayelitsha, Montana and Athlone suburbs in the Western Cape. A full description of the research settings is presented in the introduction.

All the HIV positive children were identified by the social workers in each setting as they were assisting with the initial set up of appointments prior to testing. All children admitted to the institutions visited in Khayelitsha were tested for HIV or admitted due to their HIV status and home circumstances. Participants were identified and recruited from July 2006 to September 2006. Reliability testing occurred during September 2006. Baseline testing of the participants occurred during October 2006 to December 2006. The follow-up six-month testing took place from April 2007 to June 2007. Methods used in identifying and recruitment of participants are described below.

3.3.1 Sample size

The sample size of the study was calculated using data from a study on isi-Xhosa speaking children who were attending a day care centre in Khayelitsha. The study reported the mean developmental quotient on the Peabody Developmental Motor Scale as 103.83 (standard deviation = 10.84). A difference of 10 points was

regarded as being clinically significant. The formula below was used in the calculation of the sample size [68]:

$$n = \frac{8(CV)^2}{(PC)^2} * (1+(1- PC)^2)$$

where PC is the proportionate change in means ($PC = (\mu 1 - \mu 2)/\mu 1$) and CV is the coefficient of the variation ($CV = \delta 1/\mu 1 = \delta 2/\mu 2$).
(μ=mean; δ=standard deviation)

Illustration: The sample size therefore became

$$n = \frac{8(10.84/103.83)^2}{(10/103.83)^2} * (1+ (1-10/103.83)^2)$$

$$= \frac{8(.104)^2}{(0.96)^2} * (1+ (1-0.96)^2) = 17$$

A sample of 17 children was required in each of the comparative groups, but as there was likely to be a number of children who would be lost to follow-up, it was anticipated that 20 children would have been recruited in each group.

Two participant groups were identified in each of the two settings identified, four groups all together. Specific inclusion and exclusion criteria are discussed below and these had been developed for the specific groups that have been identified.

3.3.2 HIV infected sample

Two groups were identified and these groups included the children living in institutions with a diagnosis of HIV and fostered children who had a diagnosis of HIV.

3.3.3 Inclusion criteria

Children between the ages of three to six years whose HIV status had been confirmed as positive after relevant testing were included into the study.

3.3.4 Exclusion criteria

Specific exclusion criteria of the sample included:

- Children who were born with a neurological impairment e.g. cerebral palsy, Down's syndrome. Children in these categories were identified by clinical examination of the researcher who has had extensive experience with children with neurological impairments or by medical diagnosis by a paediatrician or doctor attending to the child.
- Children presenting with an acute illness, fever, malaise or hospitalisation during the recruitment phase.
- A diagnosis of profound hearing loss or visual impairment
- Children with a diagnosis of any congenital abnormalities
- Foetal Alcohol Syndrome - Children were identified through clinical examination by the researcher who has had extensive experience with children with FAS or by medical diagnosis by a paediatrician or doctor attending to the child. These included specific facial features (abnormalities), past history of the child, very low birth weight, small head circumference, and adequate history from staff at institutions.

3.3.5 The HIV negative sample

Two groups were identified and included children living in institutions presumed to be HIV negative and children in foster care whose HIV status was presumed to be HIV negative.

3.3.6 Inclusion criteria

Children between the ages of three to six years, whose HIV status had been confirmed as negative after relevant testing, were included in the study.

3.3.7 Exclusion criteria

Specific exclusion criteria included:

- Children who were born with a neurological impairment e.g. Cerebral Palsy, Down's syndrome. Children in these categories were identified by clinical examination of the researcher who has had extensive experience with children with neurological impairments or by medical diagnosis by a paediatrician or doctor attending to the child
- Children presenting with an acute illness, fever, malaise, hospitalised children
- Diagnosis of profound hearing loss or visual impairment
- Children with a diagnosis of any congenital abnormalities
- Foetal Alcohol Syndrome - Children were identified through clinical examination by the researcher who has had extensive experience with children with FAS or by medical diagnosis by a paediatrician or doctor attending to the child. These included specific facial features (abnormalities), past history of the child, very low birth weight, small head circumference and adequate history from staff at institutions.
- A record of three or more hospital admissions as reported by the caregiver, sister in charge.

3.4 Research Instruments

Many standardized tests have been developed to assess the motor and cognitive development of children of varying ages. The Bayley Scales of Infant Development (BSID) assess developmental function of infants and children aged 1-42 months [69].

The Peabody Developmental Motor Scale – Second Edition (PDMS II) is an early childhood motor development programme aimed at assessing gross and fine motor skills of children. It is aimed at children aged 0-84 months of age. The test provides service providers with a means of testing motor development and a series of activities to improve problems that may have been identified [70]. The PDMS II is a valid and reliable instrument [21]. The PDMS II Manual reports that both validity and reliability have been demonstrated. In this revised edition of the PDMS, studies have been included which shows the absence of gender and racial bias [70].

From literature reviewed, the PDMS II is the most accurate test to assess motor development of children in this study. Good test retest inter-rater reliability was found when various studies in America and the Netherlands were reviewed on the PDMS II Fine Motor Scales in the age group, four to five year olds [71 72].

Various forms and types of instrumentation were used to gather information from foster parents and institutions.

3.4.1 Demographic Questionnaire

A questionnaire to determine the demographic, socio-economic and medical characteristics of participants was developed by the researcher to gather relevant data from participants and their caregivers. The questionnaire was printed in English and translated into isi-Xhosa by the research assistant and administered by the assistant in a structured interview prior to each assessment. Questions relating to each child, their medication, past medical history, foster parents' marital status, income, employment, educational level, housing status, family composition and whether or not they received a grant were included in the questionnaire. Each participant was questioned in the same manner to ensure reliability.

3.4.2 *Height and weight of children*

Height and weight of each participant was measured manually by the researcher prior to test administration using a tape measure attached to the wall and an electronic scale. These measurements were recorded and the BMI calculator was used to calculate BMI percentiles for the age and sex of each participant using the CDC norms[1] [38] .

3.4.3 *Peabody Developmental Motor Scales II*

The PDMS II is a standardized test which was used to assess and score motor development of all participants in the study. The PDMS II is aimed at assessing gross and fine motor skills of children aged 0-84 months of age. The test provides service providers with a means of testing motor development and also provides a series of activities to improve problems that may have been identified by the service provider [70].

The investigator was unable to find any published studies using the PDMS II on South African children. The only study the researcher found was an undergraduate study conducted at the University of Cape Town that investigated the validity of the norms of the PDMS II in South African isi-Xhosa speaking children between 48-72 months. The study found that subjects within the specific age categories performed within the developmental range as was normed for the PDMS II on American children [73].

The reliability of the PDMS II was tested prior to the initiation of the main study. This is described under Procedure.

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[1] http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx?CalculatorType=MetricSource: Centers for Disease Control and Prevention (www.cdc.gov)

The PDMS II score sheets consisted of six subtests subdivided into reflex activity (children aged 1-11months), Stationary, Locomotor, Object manipulation, Grasping and Visual Motor activities. The reflex activity subtest was excluded during testing as this subsection only applied to children under the age of 11 months. A score of zero, one or two could be used to score test items which gave the examiner an indication of the abilities of each child on the gross and fine motor subtest. Once completed, a profile/summary form was completed tabulating all raw scores, quotients, percentiles and age equivalents of each of the subtests.

3.5 Procedure

Approval for the study was granted by the Medical Ethics Committee of the University of Cape Town in August 2006. Data collection occurred between September 2006 and June 2007.

Consent was not given by the institutions and the community outreach programmes to use their names in the study and where these places of care chose not to reveal their names, these names were omitted.

A research assistant was employed at the start of the study to assist with the gathering of demographic and test information from parents/guardians/caregivers in their mother tongue and assisted with test administration with the children involved in the study. A research assistant was necessary as the primary investigator had a limited knowledge of isi-Xhosa.

Following baseline testing, parents and caregiver staff were given verbal advice regarding the inclusion of gross motor and fine motor activities into their daily programme at home. They could choose whether they wanted to utilize this information or not.

3.5.1 Information sheets for parents/legal guardians

An information sheet for each caregiver and institution was compiled by the researcher prior to the study. Each participant received an information sheet translated into isi-Xhosa by a research assistant explaining the purpose of the study, expectations of the participant during the time of testing, possible risks associated with conducting the research, benefits to the child if any delay occurs and the time for each assessment to be conducted. This was presented to them at the start of the

interview process prior to administration of the demographic questionnaire. The information sheet was translated into their mother tongue by a translator.

3.5.2 Pilot study and reliability testing

A Pilot study was conducted in September 2006 at a crèche in Khayelitsha with isi-Xhosa speaking children to test the feasibility of the instruments used by applying them to a sample of well children. The crèche, is situated in Macassar in Khayelitsha, receives German Funding for operational costs and accommodates 120 children aged three to six years.

A sample of ten well and healthy children were selected from the register for the pilot study in conjunction with an educator teaching at the school. Informed consent forms and a questionnaire were given to ten parents and guardians and these were completed prior to testing. One parent chose not to continue with the study following recruitment and another child relocated before testing was completed. These two learners were then excluded from the pilot study. Testing commenced in the school hall free of all other visual cues. The room was prepared prior to testing and two paediatric physiotherapists scored each child simultaneously while an interpreter/translator (research assistant) assisted with the interpretation of test items. A reward of ten jelly tots was given to each child on completion of all tasks.

During the pilot study, translation of the PDMS II instructions was standardized and problems relating to ambiguity were addressed. Children responded better during the morning session rather than after a break. Inter-rater reliability testing of the PDMS II was conducted. The primary investigator administered and scored the assessment sheets in conjunction with a second paediatric physiotherapist who scored her own assessment sheets. Video recordings were made but as the second assessor was present during all testing, these were not utilized for data analysis. At the end of the assessment, the researcher and observer compared their results.

A total of eight children completed the assessment.

3.5.3 Pilot study results

Basic descriptive statistics were used to tabulate and compare the ages in months of learners tested and the frequency of ages. Eight subjects were chosen with the ages ranging from 46 months to 72 months.
Five males and three females were tested.
The mean age for the learners (participants in the pilot study) was 59.4 months, the min. age being 46 months and the maximum age being 72 months (SD= 8.4).
Table 1 represents data of the age in months of children tested in the pilot study.

Table 1: Number of participants in each age category

Age (months)	n=8	Percentage (%)
40.0-49.0	1	12.5
50.0-59.0	3	37.5
60.0-69.0	3	37.5
70.0-79.0	1	12.5
TOTAL	8	100

Raw scores of items were tabulated from the standard tables provided in the manual and when comparing data between the two physiotherapists' scores, it was found that there was a difference of no more than two points on two subtests (out of a possible 89 for locomotion items, 30 for stationary items, 24 for items requiring

object manipulation, 26 for grasping activities and 72 for visual-motor activities) and a difference of no more than one point on three subtests.

Using Spearman's Rank Order Correlations, the Spearman's correlation row was consistent between the two physiotherapists scoring the data. The correlation for the GMQ was rho=.97 ($p<.01$), for the FMQ rho was =.95 ($p<.01$) and the correlation of the TMQ score ranks was perfect as rho =1.00 for all tests. It was therefore concluded that the instrument used was reliable.

3.5.4 Data collection

Data collection of the identified study sample occurred from September 2006 to June 2007. Test information from the identified sample (i.e. HIV positive and HIV negative fostered children and institutionalized children) were collected at baseline (i.e. start of the study) and again after a six-month interval.

3.5.5 Recruitment and assessment

3.5.5.1 Community sample: Foster Care

The researcher attended an initial meeting of the foster care group in Khayelitsha which was held on a monthly basis to assist foster parents with difficulties they may experience with the children they are currently fostering. The purpose of the study was explained to all those who attended and at the next meeting all eligible participants were recruited.

All foster parents who fostered children between the ages of three to six years and who did not attend the meetings were identified from the register and contacted by the social worker. Appointments were arranged by the social workers in the various care settings with the researcher.

Each child was given a specific appointment time in order to prevent an extended waiting periods should the test take longer than anticipated. The room was prepared prior to testing and all distances measured according to the specifications as described in the test manual. Each foster parent entered the testing area with their child along with the researcher and the research assistant. The purpose of the study was once again explained to each parent/foster parent at the initial assessment. A translator was present and all information was translated into the first language of each participant. Each parent and legal guardian had to complete a consent form and questionnaire prior to test administration.

All children were allowed time to play while the researcher administered the demographic questionnaire to the caregiver. Once testing had started, the foster parents were allowed to observe the assessments and were asked not to give any feedback or motivation during testing.

Data were collected three days per week at the foster care community outreach centres. In all cases, the gross motor component of the test was administered first, then the fine motor and visual motor tasks. Children were allowed to take a break to have a sip of water or go to the toilet as these facilities were available on site.

Visual motor activities and fine motor activities were performed at a child sized table with the researcher sitting directly opposite each child. All instructions were first given in English and then translated into isi-Xhosa by the assistant sitting next to the child. Testing was conducted in a quiet room, but assessments often continued outside where the test required large open areas for running and ball kicking activities. Guidelines contained in the manual were formally adhered to and no credits/points were awarded to a child if the caregiver compromised the integrity of the test. Caregivers were allowed to watch during testing as children were reluctant to be in a room alone with two strangers.

Caregivers and social workers were given feedback regarding the performance of their child after the initial assessments were concluded. They were then asked to return to the clinic in six months. They were informed that they would be reminded of their appointment closer to the time. Once testing was completed, transport money was given to each foster parent in an envelope.

Telephone numbers were taken so that the participants could be contacted either by the researcher or the social worker for the follow up appointments.

Follow up assessments were planned with the social workers prior to testing at six months in order to arrange days for testing. The researcher contacted each family prior to the re-assessment date. Many arrived for their appointments but the few who did not arrive for their appointments were followed up with home visits by the community care workers as part of their daily tasks. New appointments then had to be arranged and the home visits proved useful for follow up assessments. A few children were not available for testing and on request by the social worker; the researcher was asked not to continue testing due to severe poor home circumstances.

The testing procedure at the follow-up appointment was performed as it had been at baseline testing.

All data collected were kept in individual files for each child. Each file was identified by a research subject number to maintain confidentiality.

3.5.5.2 Institutionalised Care

A meeting was arranged to discuss the purpose and length of the study with staff at the institutions. Inclusion and exclusion criteria were discussed with the professional staff on site and eligible candidates who met the inclusion criteria were identified from a register in conjunction with the physiotherapist on site. Once all

HIV positive and negative participants were identified, they were further screened according to their ages and only those between the ages of three to six years were selected. Informed consent of parents and legal guardians was gained prior to the testing of the residents and an institution questionnaire was completed by institution staff at the institutions. Institution folders were reviewed by the researcher to gather important medical information necessary for the study and all information was treated with care and confidentially.

Staff at each institution assisted with the collection of the children from the different areas of each institution. This greatly assisted the researcher and the research assistant in limiting the amount of time spent during the day at these places of care. Each child was taken into the testing room individually to be tested. Where children did not want to be alone, a friend was taken in and allowed to play in another part of the room to allow each child to feel safe. A member of staff was allowed to sit in on testing if the child wanted this.

Testing commenced in the mornings as many of the children in the various institutions would sleep in the afternoons as part of their daily routine. Once tests were completed, the children resumed their daily tasks.

At follow-up testing, the same procedure was followed as had been at baseline testing. Follow-up appointments were arranged with the staff on site. These either included the physiotherapists, professional nurses, social workers or educators. Children discharged to the community and institutions were followed up at the appropriate institution or community project. The institutions and community care projects in the study were closely linked which provided access to children who moved from one institution in the study to another institution also in the study. Children who relocated outside of Cape Town were lost to follow up.

3.6 Data management and analysis

3.6.1 Computation of Peabody scores

Prematurity adjustment was only used when the child being tested was younger than 24 months. Prematurity was not considered after 24 months and no adjustments were made to the ages prior to recording scores. Normative tables for percentiles and standard scores were provided in the examiner's manual along with the description of age equivalents, percentiles and standard scores. The researcher used this as a reference during recording of the scores.

Raw scores are the total amount of points a child may achieve on a subtest. A score of zero, one or two could be used to score each of the test items which allowed the examiner to compare each child on the gross and fine motor subtests. Raw scores provide very little clinical value. Percentiles represent the values that indicate the percentage of the distribution that is equal to or below a particular score.

Standard scores provide the clearest indication of the child's test performance. These scores are based on a mean of 10 and standard deviation of 3. It is with standard scores that the examiners are able to make comparisons across subtests of individuals tested. Once each test was completed, a profile/summary form was completed tabulating all raw scores. The raw scores were then converted into age equivalents, percentiles and quotients on each of the subtests.

All children started at a level where at least 75% of the normative population at that age passed. This was known as the entry point. Each child was able to achieve a maximum number of points on the score sheet no matter what the age was. Each instruction may be repeated up to three times during the testing procedure.

During testing a basal and ceiling level had been established. The basal level is established once a child scores three '2's' in a row before scoring a 0 or 1. Once a basal score is established, progressively more difficult items were administered until a ceiling is established. A ceiling level is established when a child scores a '0' on three test items in a row.

Data was entered into the STATISTICA Version 7 programme for analysis by the researcher. Descriptive statistics were used to present frequencies and demographic data. As the numbers were small, the non-parametric Spearman's rank order correlation was used to test the reliability of the PDMS II after the pilot study. The Chi-Squared test was used to test for associations between gender, HIV status and place of residence. The Mann-Whitney U test was used to test if there was a significant difference in the rank ordering of data that were not normally distributed. For numeric, normally distributed data, tested by using the Kolmorogov Smirnoff test, the independent t-test was used to determine if there was a significant difference in the mean scores of different groups. Dummy variables were created for residence and HIV status and multiple regression analysis was used to determine whether age, time on ARVT, residence and or status was predictive of the TMQ at baseline and at six months. Age and time on ARVT were found not to be significant so the model including residence and status was used. A .05 level of significance was used throughout the study.

The use of percentages when reporting results were excluded as the sample size was small.

Height and weight was measured using a tape measure and electronic scale. These measurements were used to calculate BMI and its influence on the development of the children.

3.7 Ethical considerations

3.7.1 *Informed consent*

The caregiver/guardian/director of each subject at the institution was asked to sign a consent form in his/her home language before participating in the study. Social Welfare Officers were also contacted to inform them of the research for children. The director was not legally in a position to sign a consent form for children in the institution and parents/legal guardians were contacted via the social worker for informed consent. Consent was gained from parents at the crèche to video their children. However, this footage and pictures were not used during analysis. The directors of the institutions and team leaders of the community projects were asked to sign a consent form to use the names of the institutions and community projects in the study. Those who chose not to have their names used were renamed to ensure confidentiality. An isi-Xhosa speaking translator was present at all times to ensure isi-Xhosa speaking subjects understood all aspects of the research. No confidential information was obtained from the foster parents without their having given informed consent.

3.7.2 *Autonomy*

The caregiver had the right refuse to participate and withdraw at any stage of the study. Withdrawal from the study had no effect on the treatment being administered at the institutions or at community health care centres for those who received treatment in the community.

3.7.3 *Testing*

Testing took place at the institutions and community centres on various days of the week and this was decided in conjunction with the specific institution and team leader of the community project.

3.7.4 Non-maleficence

A major ethical concern was that the testing should not harm or tire out the child. The well being of the child was considered at all times and testing was stopped if the child became distressed. The researcher ensured that all safety procedures were in place before testing began and steps were taken to ensure that the child was protected as far as possible.

3.7.5 Beneficence

Where evidence of developmental delay existed, the researcher in her capacity as a trained physiotherapist advised the mother or institution on how to explore the child's potential for further development through the use of therapeutic play. Each foster parent was given transport money (R50.00) to attend the assessments along with their child at the community offices of the foster care agency. A sandwich was given to each foster child after the assessment on request by the social worker. In the case of the participants in the institutions, a donation was made of toys and nappies to the same value.

The educators were given a copy of the test sheet following the six monthly follow-up testing sessions with highlighted activities for the educator to practice during activity time.

3.7.6 Confidentiality

Information gained from the subjects would only be divulged to other medical practitioners provided that the caregiver consents. The gathering of demographic, socio-economic status and all other data was handled in a sensitive manner by the isi-Xhosa speaking research assistant. In all other circumstances, absolute confidentiality was maintained. Participant's data were identified by a number to

protect their privacy and were analysed along with information about other participants. All data was kept confidential and no data was linked to individuals. The information gained by the study may be published, but names will not be used in any publication without written consent.

4 Results

The data outlined in the following chapter are presented according to the specific objectives as stated in Chapter 1.

Firstly, the identification and eligibility of the sample is presented along with the description of the demographic and medical characteristics of the sample. This includes the health status of the sample. Secondly, demographic details of the care-giving environment are described, along with the description of the comparison between services available to children in the various residential settings. Thirdly, the motor performance of the children with HIV was compared with those without HIV and the difference in performance between the children living in institutions and children living in the community is examined. Finally multi-variate analysis was done to establish the predictors of TMQ.

4.1 Sample

4.1.1. Identification of the sample

A total of 61 children were identified by age from a register at the institutions and a register at community outreach programmes (held by the social workers) and recruited to participate in the study. All foster children had been placed into foster care by social workers working in conjunction with the community workers and had previously been in institutions or places of safety. There were 37 children in the institutions and 24 children in foster care who were screened for eligibility in conjunction with the social worker working with each child. No foster parents refused to participate in the study. Sixteen participants were excluded from the original sample once they were screened as they had the following exclusion criteria: Two had Foetal Alcohol Syndrome, one was a congenital toe walker, one had a severe hearing impairment, four were on acute cancer treatment and one on dialysis with recurrent admissions to hospital, five were excluded as they would

The mean age of the participants in the study at baseline was 52.75 months (SD = 10.88; Range = 35.7 – 73.8 months).

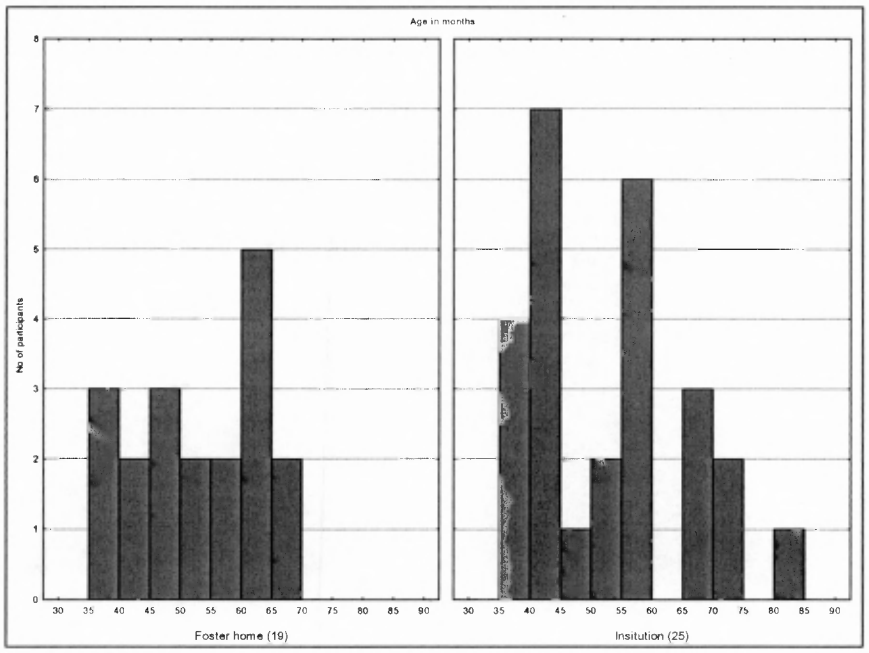

Figure 2: Age (months) of sample (n=44)

As the ages were not normally distributed, the Mann-Whitney U was used to test if the ages of the children in the homes were ranked the same as those in foster care. There was no difference between the samples, (U=199, p=.360). Similarly the ages of those with HIV and without HIV were the same (U=181, p=.155). Table 2 demonstrates the residence, gender and HIV status of the sample.

Table 2: Status and residence of the final sample recruited (n=44)

Residence	Gender	Status Tested-	Status Tested+	Totals
Foster	Female	6	2	8
Foster	Male	3	8	11
Total Foster		*9*	*10*	*19*
Home	Female	5	7	12
Home	Male	7	6	13
Total Home		*12*	*13*	*25*
Total		***21***	***23***	***44***

There was no association between gender and residence (Chi=.15, p=.70) or between HIV status and residence (Chi=.002, p=.97). There was no difference (p=.5) in the mean age at which children were placed in foster care (24 months, SD=20.1) and in institutions (28.3, SD=19.2). Children had spent a mean of 31.4 (SD=18.8, range 4-58 months) in foster care and 26.4 (SD=17.7, 1-65 months) in institutions (see Figure 3). This was not statistically different (p=.390).

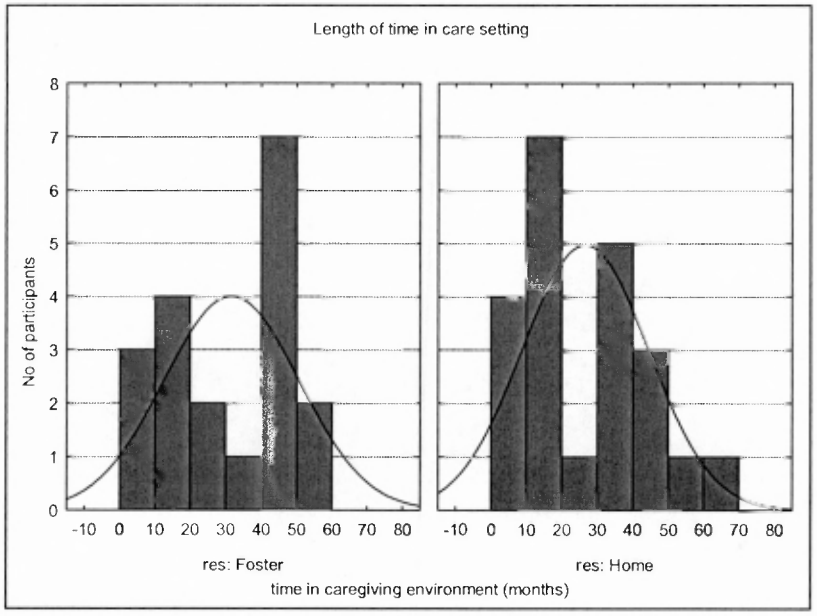

Figure 3: Length of time spent in foster care (n=19) compared to institutional care (n=25)

In summary, there appeared to be no difference in the foster care and institutionalised samples with regard to demographic variables.

4.2 Demographic details of mothers and foster mothers

4.2.1 Age of foster mothers

The mean age of the foster mothers in the study (n=19) was 46.5 years (SD=9.2, range 30-59). Nine of the foster mothers caring for the foster children were in the 50-59 year age category, while six parents were in the younger age category of 30-39 years of age.

4.2.2 Socio-economic characteristics of foster parents

Table 3 outlines the socio-economic characteristics of the foster mothers.

Twelve of the foster mothers were married with partners and living in the same household as a family, five were previously married but widowed and two were single mothers. The mean educational level of the foster parents was Grade 9 (mean=9.5, SD=2,). None of the foster parents progressed past grade 12. None of them had enrolled in tertiary educational facilities.

None of the foster parents were of pensionable age. Seventeen parents received a foster care grant for their child. Of these 13 parents relied solely on the foster care grant they received, while three had partners who provided the primary source of income and supported the family financially to assist with the care of the foster child. Three received an additional disability grant for themselves. Two parents were formally employed which was their primary source of income to care of their families with the additional assistance of foster care grant. Several foster mothers supplemented their income and nine foster parents raised funds to assist them financially by selling items (e.g. luxuries – chips, drinks, and sweets), selling their own produce from self-help projects or selling hand made items from community projects that had been established. Five parents were unemployed.

Fourteen foster parents had their own children or grandchildren living with them at the time of fostering another child. Many of these parents were on a register with the Department of Welfare/Social Services for relief/emergency care and short term/long term foster care.

Table 3: Socio-economic profile of foster parents (n=19)

Variable	Category	n=19
Relationship	Single	2
	Married/ Partner	12
	Widowed	5
Educational Level	Grade 3-7	4
	Grade 8-11	11
	Grade 12	4
Employment Status	Unemployed	5
	Formally employed	5
	Informally Employed	9
Housing status	Formal	11
	Informal	8
Grant Status	Foster Care	17
	Disability	3
	Pension	0
Total		

4.2.3 Biological mother status

Ten children fostered lost their biological mothers due to death and nine of the foster parents did not know where the biological mothers of their children were as they were placed directly from various institutions caring for orphaned or abandoned children. One mother cared for a neighbour's child who was poor and

unable to afford to look after her child. Information on the foster children regarding maternal health and exposure to antiretroviral prophylaxis was not available as the foster parents were not privy to the information.

4.3 Care-giving environment

4.3.1 Stimulation in foster homes

At baseline, 14 foster care children attended formal playschool/crèche, while five were home with foster mothers. At the time of follow-up, all foster care children were enrolled at a crèche or school and participated in formal and informal schooling and play activities.

4.3.2 Support services in foster homes

No family had had contact with allied health professionals (Occupational Therapist, Physiotherapist, Speech and Language Therapist) for screening, assessment purposes or intervention. This included contact through home-visits, their local day clinics, community health centres or community outreach projects. Fourteen of the families had support services (social workers/trained field workers) who conducted regular home visits. Five did not have home support services but attended monthly support meetings and training sessions organised by the community programmes for follow up. If the need had arisen, food parcels could be collected at the various community outreach centres.

4.3.3 Housing - institution sample

All institutions visited by the researcher were considered to be a type of formal housing on a large scale which housed the participants in the study. These

institutions were well funded by private and government organisations and all the children and staff had access to clean, running water and electricity.

Children lived in dormitory type rooms where two carers attended to 12 to 20 children. Bathrooms were shared and each institution had times scheduled for bathing.

4.3.4 Institution programme and stimulation in institutions

All institutions followed a programme whereby all children had set times when they received meals, activity time and rest/sleep time. Breakfast, lunch and supper were always served at specific times, along with two snacks for the day. All children had an informal activity programme (play time) mid morning before lunch and a period of rest in the afternoons. Supper was served early (at 16h30pm) with an evening snack after supper.

Two institutions had facilities for formal pre-school activities; one had a crèche used for informal play activities facilitated by a carer with no training as an educator while the older children attended a formal school setting across the road from the institution. In the months after baseline testing the institutions became aware of the need for more formal, constructive play and employed an educator in January 2007. The third institution had formal schooling up to grade 10 as they housed older learners as well. One home only accommodates children 0-5 years and the need for formal schooling beyond this stage was not necessary but an educator facilitated constructive schooling and informal play sessions on a daily basis.

All children at institution A were placed into formal school/crèche setting at the beginning of 2007. Those tested were included into occupational therapy groups to improve hand eye co-ordination and fine motor activities.

All the institutions visited and included in the study had a large number of volunteers implementing activity programmes, music programmes and assistance with the daily care of the children. A large number of NGO's are also providing community outreach programmes at institutions in order to uplift these communities.

4.3.5 Housing of foster children

Formal type housing was considered for this project to be a housing brick structure with clean running water, a toilet on the inside and electricity. Eleven foster families lived in formal type housing and eight lived in informal type housing. Ten homes had inside running water and all had electricity inside. Eight families lived in informal housing i.e. corrugated structures, and of this three had outside water and seven had electricity. The formal housing structures were one level brick structures with small rooms to accommodate those living in the homes. The average number of rooms in each of the homes (whether formal or informal) were 2.4 rooms (excluding the bathroom and kitchen), while the average number of people living in each house was 5.9. One family lived with 12 people in a three bed-roomed informal house that had no electricity or running water within the house.

4.3.6 Accessibility of clinics/medication and service provision

All children housed at the institutions had access to acute and rehabilitative medical care. The institutions all had a professional nurse on site to ensure proper nutrition, compliance with medication, and general well-being of each child, a social worker seeing to the social and psychological needs of the child and care workers for daily care and assistance with ADL. Two institutions had the therapeutic services of either physiotherapists or occupational therapists or both. One institution did not have a physiotherapist or occupational therapist on site. Access to these services were easily available when compared to the community foster care sample as

children were more closely monitored in the institution and transport services to distant hospitals were more accessible.

Transport for children to follow-up clinics at the tertiary hospitals was always available for children in the institutional settings to attend, which allowed regular, holistic monitoring of each child. An adequate system of referral existed between the institutions and hospitals and the needs of each child were adequately followed e.g. nutrition advice from the dietician.

4.4 Health status

As mentioned previously, few of the foster parents were in possession of a Road to Health Card and many of these were found to be incomplete. This information was therefore not utilized. Similarly, foster parents had very little or no information regarding the status of the child's biological mother, history of pregnancy and birth history and this could not be analyzed.

All children who had tested HIV positive were on antiretroviral therapy and all children had been on treatment for five months or more. However, data on the date of initiation of medication was missing in the folders of four children. Consequently tests done with time on ARVT only included 19 subjects. Over half had been on treatment for 18 months or longer (Figure 4).

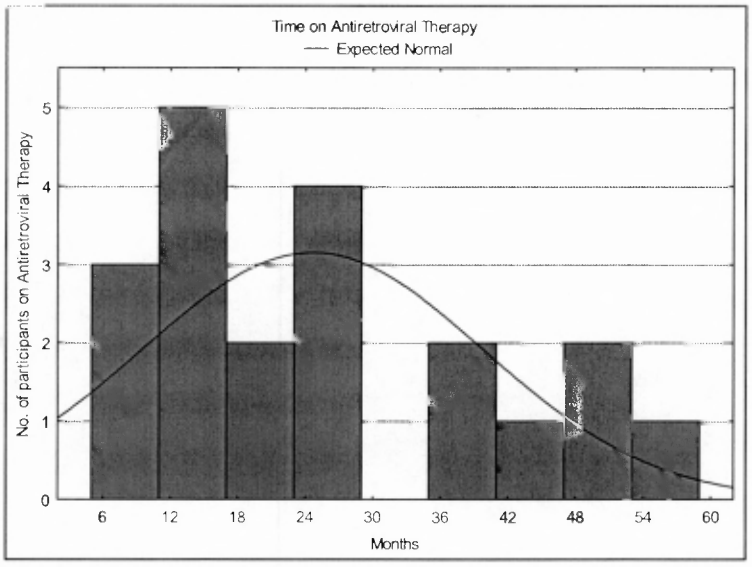

Figure 4: Time on Antiretroviral Therapy (months) (n=19)

Most children with HIV were reported to have experienced serious illness during the course of their lives and these are reported in Table 4.

Table 4: Frequency of opportunistic infections over the life-span of the HIV positive group (n=23)

	Count	Percent
Gastro-enteritis	14	60.9
TB	13	56.5
Ear Infection	7	30.4
Pneumonia	5	21.7
Seizure	5	21.7
Meningitis	2	8.7

The two children who had had meningitis showed no signs of motor dysfunction and were included in the study. It was found that most children had been healthy in the three months prior to testing. This is indicated by the limited number of hospital admissions prior to and during the study as only one out of 44 children had been

admitted to hospital in the three months prior to commencement of the study. The child spent one day in hospital following seizures. She was discharged in the care of the staff at the institution. During follow-up data collection, one child was placed in foster care and was admitted to hospital while at home due to serious illness as a result of neglect. This child was therefore not tested at follow-up, although his baseline data were included.

4.4.1 Body Mass Index

The mean BMI percentiles for age and gender are shown in Table 4 with regard to status. There were two missing values. One child with HIV was severely obese and scored above the 100 percentile. His score was omitted from analysis as he was clearly an outlier. The HIV negative group scored significantly higher however there was only one child with HIV who scored below the 5th percentile and was categorised as being underweight.

Table 5: Means of Body Mass Index Percentiles for age and gender (n=41)

	Mean HIV +	Mean HIV -	t-value	df	P	N HIV +	N HIV -	Std. Dev.	Std. Dev.
Percentile	58.8	75.8	-2.15	39	0.038	22	19	31.4	15.0

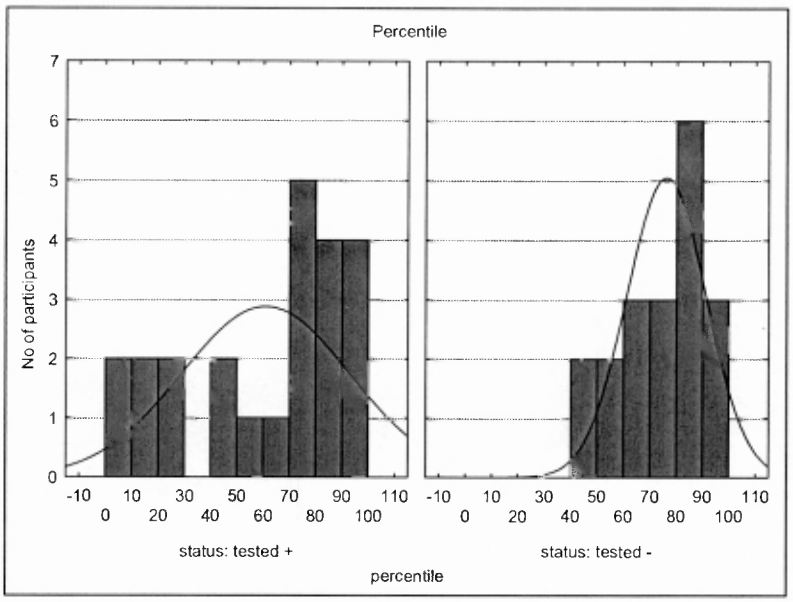

Figure 5: Percentile distribution of Body mass index normed for age and gender of the HIV positive and HIV negative groups (n=43)

There was no significant difference between the mean percentiles of the children in the two residential settings (p=.39).

4.4.2 Accessibility of health care and rehabilitation services

Medical services were directed at the direct management of the child's status, management of opportunistic infections and administration of medication. Foster children on antiretroviral therapy in the community all had access to their community day care centres or community clinics where they had access to ARVT. They did not have to travel out of their communities to access medication at tertiary hospitals but each child was required to attend a regular follow-up session at RXH, Tygerberg Hospital or GSH to assess the efficacy of the treatment, general health of the child and compliance with medication. Eight parents of the foster care community were able to walk to their nearest community clinic or health centre while 11 families were required to take a taxi or use other means of getting to the clinic.

4.5 Scores on PDMSII

4.5.1 Comparing HIV positive and negative children at baseline

The GMQ, FMQ and TMQ were all normally distribute using the Kolmorogov Smirnoff test (in each case p>.20) (See Figures 4, 5 and 6) and therefore parametric tests were used. No correlation was found between age and TMQ (r=.03, p=.833) which implies that the older children did not perform relatively better than the younger children.

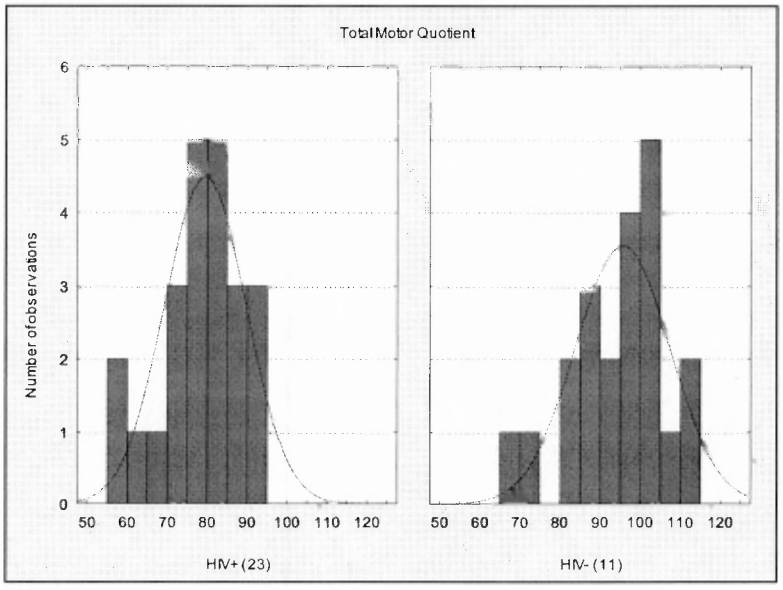

Figure 6: Total Motor Quotient of HIV positive compared to HIV negative children at baseline (n=44)

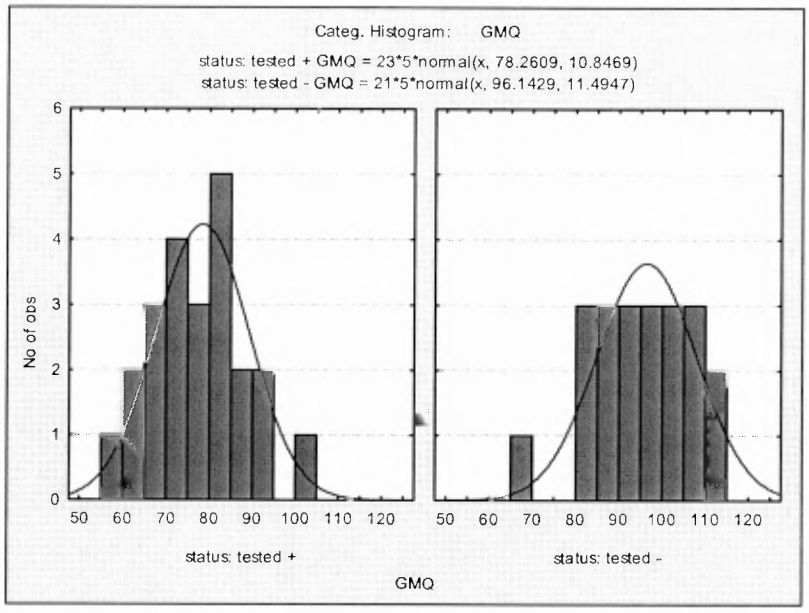

Figure 7: GMQ of HIV positive and HIV negative children at baseline (n=44)

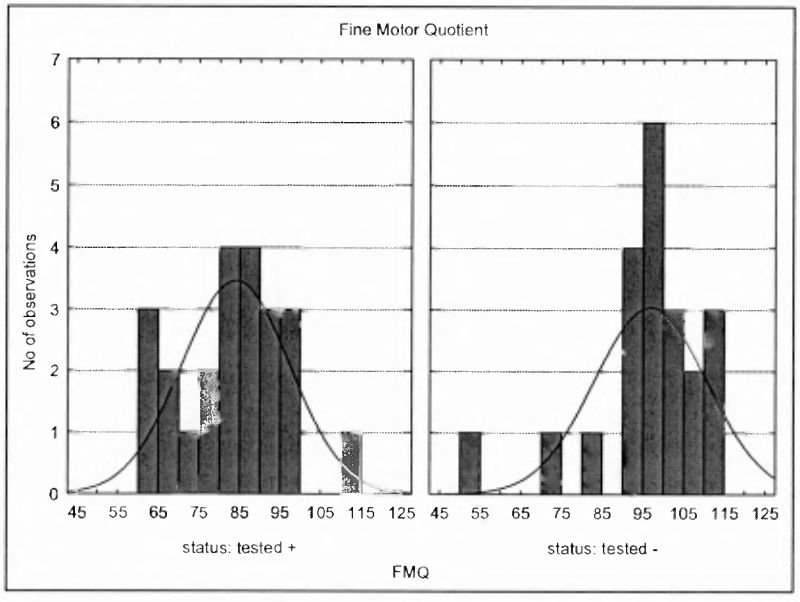

Figure 8: FMQ of HIV positive and HIV negative children at baseline (n=44)

The t-test was used to compare the performance of the HIV positive children and the HIV negative children. The difference between the mean scores of all the

sections was statistically significant (See Table 6) and the children with HIV performed significantly worse than did the other children. The difference was greatest in the GMQ where the mean difference was 18.3. The difference in means was 12.7 and 16.0 for the FMQ and TMQ respectively.

Table 6: Comparison between children with HIV and those testing negative

	Mean tested +	Mean tested -	t-value	df	P	Valid N tested +	Valid N tested -	Std.Dev. tested +	Std.Dev. tested -
GMQ	77.9	96.1	-5.3	42	0.00	23	21	11.5	11.5
FMQ	83.8	96.6	-3.1	42	0.00	23	21	13.2	13.8
TMQ	79.3	95.3	-4.8	42	0.00	23	21	10.2	11.8

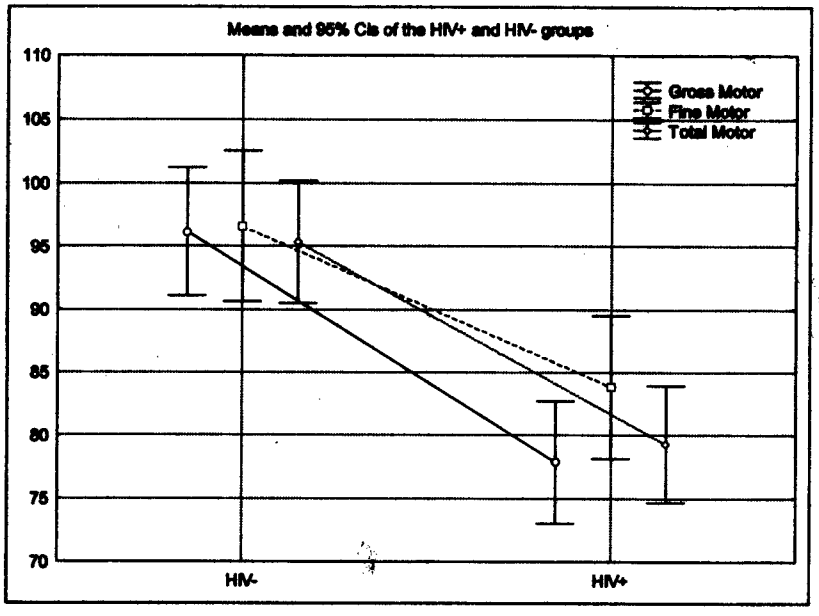

Figure 9: Comparison of the scores of the Gross Motor, Fine Motor and Total Motor Quotients of the two HIV status groups (n=43)

In children with HIV, the FMQ bordered on being statistically greater than the GMQ (p=.08). There was no difference in TMQ between males and females in the combined group (p=.78) and in the HIV positive group (p=0.39). There was no significant difference between the male and female mean scores in any section in the children with HIV.

4.5.2 Comparison between HIV positive children in different residential settings at baseline

Although the sample sizes were smaller than anticipated, the data were found to be normally distributed so that t-tests were applied to compare the HIV positive children in the different residential settings.

Table 7 indicates that there was a difference in the means of the TMQ and FMQ when comparing the children in foster care to institutional care. A non-significant difference of 4 points was found between the means of the GMQ, whereas a greater difference in the means occurred with the FMQ and TMQ (10 points and 8 points respectively).

Table 7: Difference in means of GMQ, FMQ, TMQ for children in foster care (n=19) and in institutions (n=25)

	Mean Foster	Mean Home	t-value	df	p	Valid N Foster	Valid N Home	Std.Dev. Foster	Std.Dev. Home
GMQ	83.5	88.9	-1.2	42	0.23	19	25	16.5	12.9
FMQ	84.5	94.0	-2.2	42	0.03	19	25	18.8	9.3
TMQ	82.2	90.6	-2.1	42	0.04	19	25	15.8	10.6

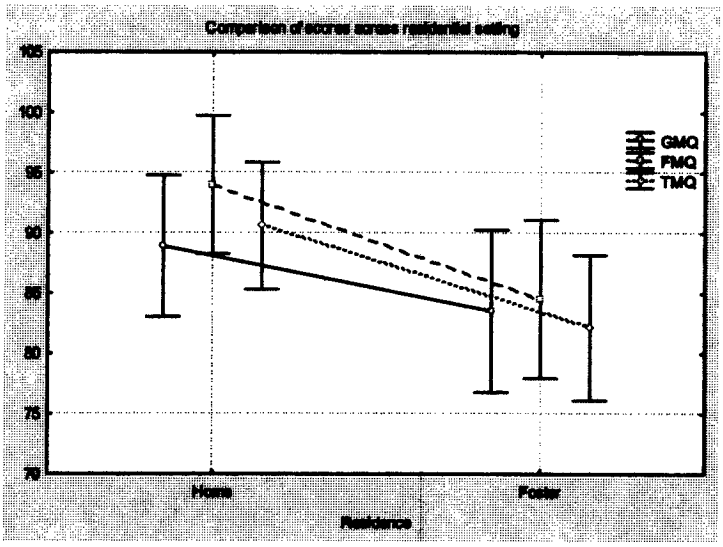

Figure 10: Comparison of the scores of the Gross Motor, Fine Motor and Total Motor Quotients of the two residential groups (n=43)

Table 8: Comparison of means for TMQ, GMQ and FMQ for HIV positive children (n=23)

	Mean Foster	Mean Home	t-value	df	p	Valid N Foster	Valid N Home	Std.Dev. Foster	Std.Dev. Home
GMQ	75.60	79.62	-0.82	21.00	0.42	10	13	14.25326	9.142743
FMQ	75.10	90.54	-3.36	21.00	0.00	10	13	12.81015	9.234134
TMQ	73.60	83.69	-2.65	21.00	0.02	10	13	10.65833	7.663600

When comparisons based on HIV status were done, a significant difference was found in the HIV positive group between the scores on the FMQ and the TMQ, as indicated in Table 8, with the foster children performing worse. No difference was found between the two residential settings for the HIV negative children, although in every case the children in the institutions scored higher than the foster children.

4.5.3 Comparison of scores at 6 months

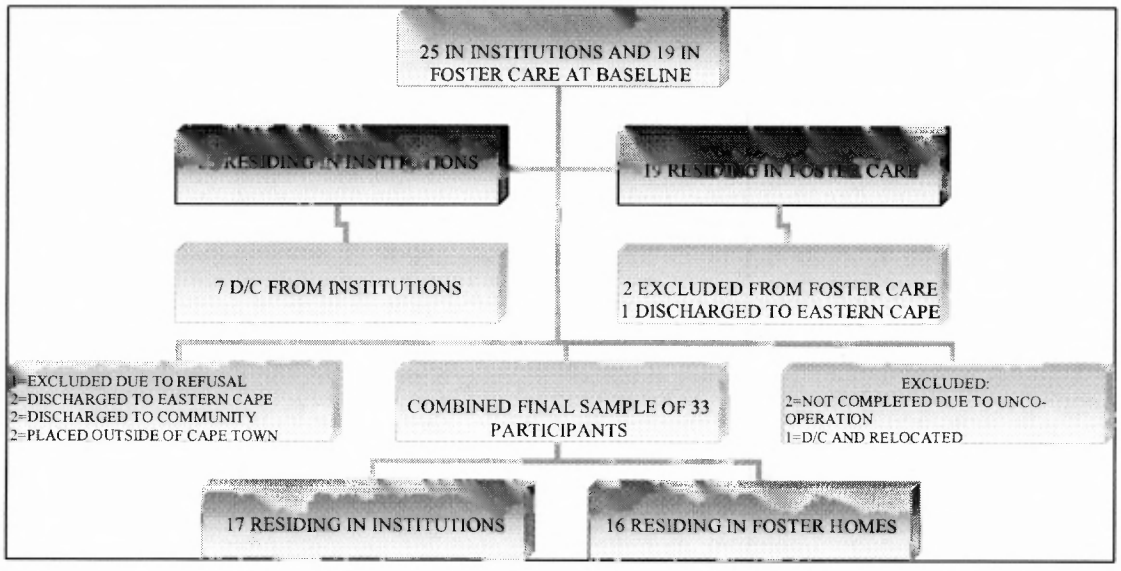

Figure 11: Organisational chart of Attrition

Three tests (two from foster care and one from the institutions) were incomplete at the time of follow up as the children were uncooperative and despite considerable effort to engage the children, testing could not be done. The test was attempted on more than one occasion but yielded the same incomplete result.

Seven children were discharged from the various institutions at follow up. Two children were discharged to the community where one was admitted to hospital and

one was not to be contacted on request by the social worker as the child was in poor home circumstances. Two were discharged to the Eastern Cape, two discharged to a children's home in Worcester, one to his biological parents, who refused to attend the follow up testing session. In total 33 children were tested twice, 21 of whom were HIV positive.

The baseline TMQ was highly correlated with the six month TMQ ($r=.76$, $p<.001$) although table 9 indicated that the combined group of children had significantly improved in GMQ 2, FMQ 2 and TMQ 2 (i.e. six month follow up).

Table 9: Comparative scores at baseline and at follow-up (n=32) of all children

	Mean	Std. Dev.	N	Diff.	Std.Dv. Diff.	T	df	p
GMQ	84.750	14.852						
GMQ2	93.313	14.164	32	-8.563	9.384	-5.162	31.000	0.000
FMQ	90.091	14.668						
FMQ2	99.273	15.168	33	-9.182	10.815	-4.877	32.000	0.000
TMQ	85.419	13.774						
TMQ2	95.065	15.325	31	-9.645	7.808	-6.878	30.000	0.000

Table 10: Comparative scores at baseline and at follow-up (n=20) of children with HIV.

	Mean	Std. Dev.	N	Diff.	Std.Dv. Diff.	T	df	p
GMQ	77.000	11.711						
GMQ2	86.400	12.271	20	-9.400	8.268	-5.085	19.000	0.000
FMQ	83.43	13.77						
FMQ2	94.43	15.60	20	-11.0	11.59	-4.35	20	0.000
TMQ	78.20	10.53						
TMQ2	88.50	14.08	20	-10.3	8.578	-5.37	19	0.000

Figure 12 shows the comparison of the HIV positive TMQ from baseline to six month follow-up.

In contrast to the baseline scores, there was no significant difference between the scores of children in the two residential settings for either the HIV positive or HIV negative group.

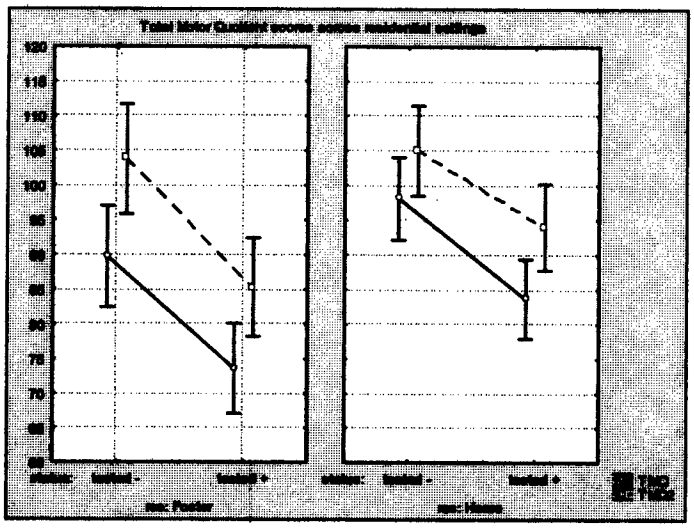

Figure 12: Comparison of change across residential settings of Total Motor Quotient (TMQ) between baseline and six months (TMQ2) (n= 33)

4.6 Relationships between other variables with TMQ

4.6.1 BMI and TMQ

No correlation existed in the whole sample between TMQ and BMI (r=-.04, p=.78) after one child (Case 5), who was clearly an outlier that exerted considerable leverage, was excluded. This child had a very high BMI (26.8) and a TMQ of 58. Inclusion of this child's scores resulted in a significant negative correlation for the entire group. A significant negative correlation was found in children with HIV between BMI percentile and TMQ (p=0.009).

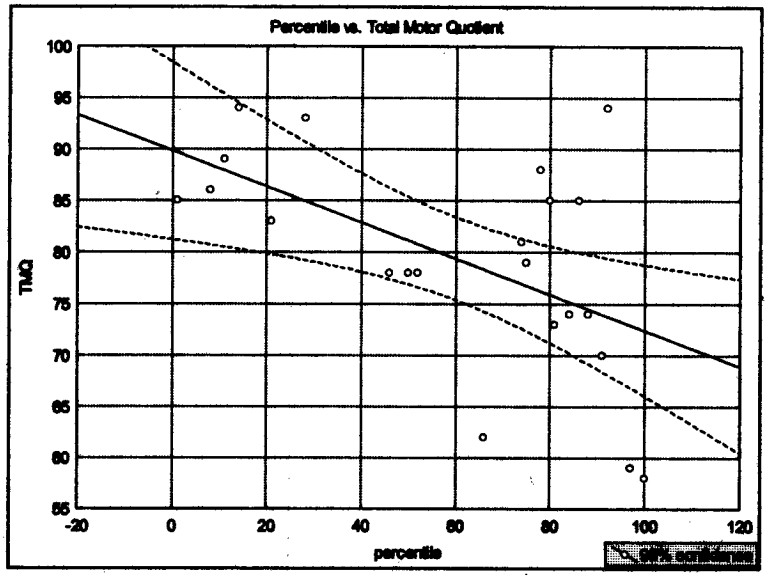

Figure 13: Relationship between percentile BMI and Total Motor Quotient in children with HIV (n=22)

4.6.2 The relationship between ARVT and BMI and TMQ

A marginally significant relationship was found between time on ARVT and BMI ($r=.44$, $p=.054$) which indicated that the percentile on the BMI value normed for age increased as the time on ARVT increased. See figure 14.

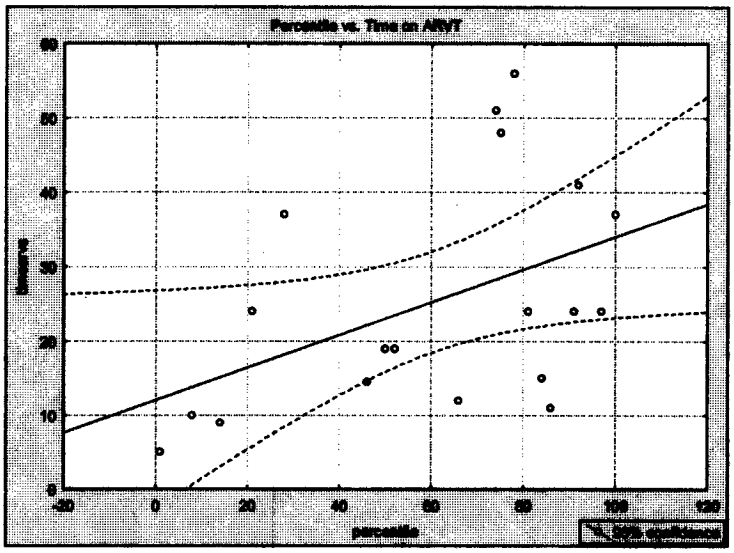

Figure 14: The relationship between Percentile BMI and time on ARVT (n=19)

However no relationship was found between the TMQ and the time on ARVT (r=.09, p=.71).

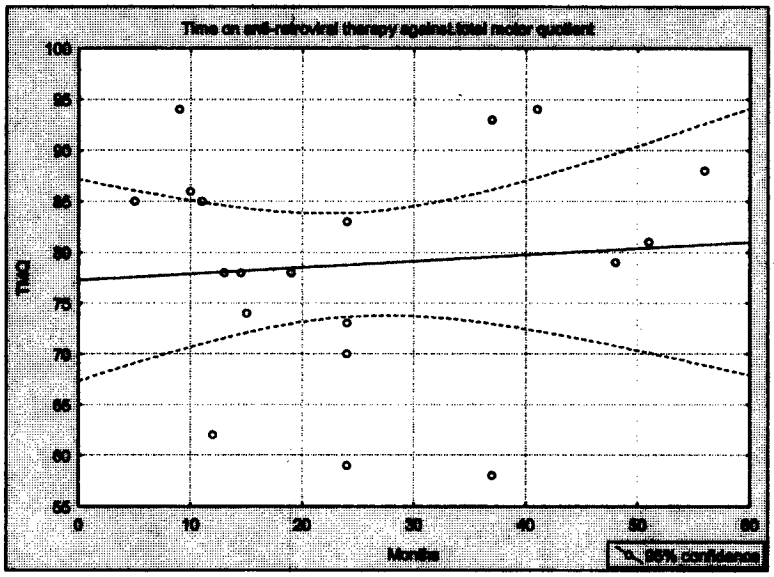

Figure 15: Relationship between Total Motor Quotient and Time on ARVT (n=19)

4.7 *Variables predictive of TMQ scores*

Forward stepwise multiple regression analysis was performed with TMQ as the dependent variable. Age and BMI and dummy variables (coded as 0, 1) for gender, residence and HIV status were entered. Case 5 was excluded as BMI was to be examined. The model that best fitted the data included status and residence as the other variables did not contribute significantly to the predicted value. Table 11 includes the multiple regression analysis results for TMQ with only status and residence entered. As BMI was not examined, Case 5 was included. The model accounted for 42% of the variance (Adjusted R squared = .42).

Table 11: Factors that predicted the baseline Total Motor Quotient score (n=44).

	B	Std.Err.	t(41)	p-level
Intercept	98.9	2.616	37.81	0.000
Status (HIV+)	-16.0	3.106	-5.14	0.000
Residence (Foster Home)	-8.3	3.132	-2.66	0.011

Residence was significant in that children in institutions were predicted to score 8.3 points higher than children in foster care. Similarly children without HIV were predicted to score 16 points more than their counterparts without HIV. Table 12 compares the predicted scores of a child living in foster care who is HIV positive (Case A) with a child living in the institution who is HIV negative (Case B).

Table 12: Example of calculation of predicted Total Motor Quotient for two hypothetical cases.

	B-Weight	Value	B-Weight in Case A		B-Weight	Value	B-Weight in Case B
Foster Home	-8.34	1	-8.34	Institution	-8.34	0	0.00
HIV+	-15.98	1	-15.98	HIV-	-15.98	0	0.00
Intercept			98.91	Intercept			98.91
Predicted			**74.59**	**Predicted**			**98.91**
-95.0%CL			68.97	-95.0%CL			93.63
+95.0%CL			80.21	+95.0%CL			104.19

The baseline TMQ was highly correlated with the six month TMQ ($r=.76$, $p<.001$) and when it was included in the model there were no other significant predictors. It was excluded as the same factors which predicted the baseline measurement were likely to predict the six month measure and these factors were therefore obscured by the inclusion of the baseline TMQ. Consequently the same baseline model was applied to the six month TMQ to determine if the same factors continued to be predictive. The predictive value of residence was not significant although the HIV status still resulted in a significantly lower score (18.3 points less). Note that only 33 children had a full set of data for this analysis.

Table 13: Factors which predict six month Total Motor Quotient (n=33)

	B	Std.Err.	t(31)	p-level
Intercept	109.5	4.294	25.49	0.000
Status (HIV+)	-18.3	4.704	-3.88	0.001
Residence (Foster Home)	-5.4	4.504	-1.21	0.238

Regression analysis on children with HIV was done entering age, gender, time on ARVT, age at onset of ARVT and residence. Because the univariate correlation between growth percentile and TMQ was negative and therefore counterintuitive, this was not included in analysis. The model did not fit the data very well and the adjusted R squared value was only .29. Residence again emerged as a significant predictor and residence in a foster home resulted in a decrease of 13.6 points on the TMQ.

Table 14: Factors which predicted the Total Motor Quotient at baseline of children with HIV (n=19, 2 sets of missing data with regard to ARVT)

	B	Std.Err.	t(17)	p-level
Intercept	79.3	3.947	20.08	0.000
Residence	-13.6	4.423	-3.08	0.007
Time ARVT	0.3	0.149	1.72	0.103

Two sets of missing data occurred as the folders of the children had no recorded date of initiation of medication. Also, staff were not aware of when the children started ARVT.

Forward stepwise analysis with the six month TMQ score as dependent measure and the same variables as above indicated that only residence and time on ARVT were included in the model. The adjusted R square was .19.

Table 15: Factors which predicted the six month Total Motor Quotient at baseline of children with HIV (n=16)

	B	Std.Err.	t(16)	p-level
Intercept	83.0	6.814	12.17	0.000
Residence	-13.4	6.282	-2.14	0.048
Time on ARVT	0.4	0.212	2.01	0.061

4.8 Summary of results

The sample consisted of 44 children, of which 25 resided in institutions and 19 in foster-care with a mean age of 52.75 months (SD = 10.88; Range = 35.7 – 73.8 months). Twenty one children had HIV. There was no difference in the distribution of gender or HIV status between the two residential settings. All the children were of black African or mixed descent. Six months later 37 children were tested.

Children had been placed in care at approximately the age of two years and had spent about the same amount of time away from their natural parents at the time of the study. The foster caregivers were older than might be expected of the natural mothers of the children and many were unemployed and were in informal employment. There were more opportunities for play and stimulation in the institutions as a set programme was followed and there was additional input from volunteer workers on a regular basis.

All the children were receiving ARVT and had been on treatment for five months or more. They showed no signs of opportunistic infections during the course of the study. In addition only one child was hospitalised, but this was not related to his HIV status and was due to neglect by the foster parents. All children in institutions had increased access to medical services, particularly rehabilitation services. There was no difference in the percentile scores of BMI between the children in the two residential settings. However, as expected children with HIV scored significantly lower, although only one child was classified as being underweight according to the CDC criteria. Length of time on ARVT was found to be correlated with BMI percentile.

As anticipated, children with HIV were significantly delayed in their motor development compared to children without the disease. In addition, children living

in the institutions scored significantly higher at baseline than the fostered children in all aspects of their motor development and the difference in the GMQ was the highest.

The longitudinal component indicated that all children increased their TMQ over the six months of the study and that the baseline TMQ was highly correlated with the six month TMQ. Although the difference between the two HIV groups remained significant, particularly with regard to GMQ, the difference in score between children in the two residential settings lost significance over the study period.

For the whole group, in addition to HIV status, place of residence emerged as a predictor of TMQ at baseline with children in foster homes scoring approximately 5 points (entire sample) or 13 points (HIV positive sample) lower than those in the institutions. Place of residence lost its predictive value at six months. In the children with HIV, in a model including place of residence, length of time on ARVT and age of commencement of ARVT only place of residence was predictive of TMQ. This remained true at six months.

5 Discussion

5.1 Introduction

The discussion firstly discusses the samples that were recruited in order to establish whether the results can be generalised to other groups of children. The specific objectives of the study as summarised above are examined and the limitations of the research are identified. Furthermore, recommendations are provided for future research and possible policy recommendations are included.

5.2 Sample

5.2.1 Demographics

All children were of either black African or mixed descent. The South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey of 2005 has reported that black communities and those living in townships are most at risk of developing HIV compared to those in formal urban areas [9].

Sample size determination indicated that 17 children were required in each of the four groups. Unfortunately this was not achieved, although every eligible candidate was recruited to the study and no foster parents or institutions refused consent. It might have been useful to extend the age limits as many children in the homes were either under the age of two years or in the community where children were over the age of seven years and of school going age. However the PDMS II is limited to testing children under the age of 83 months and there were very few younger children in foster care. There were 61 children resident in the foster homes and institutions that were included in this study. Of these, 44 children met the entrance

criteria and consequently the sample size was less than anticipated which may have contributed to under powering the study. The longitudinal study sample was further decreased due to attrition but this is common in a highly mobile population where many people do not own their own rooms/homes [67]. A decrease in the sample size may further impact on the study in that the results of the study should be interpreted with caution and the interpretation should be limited to this group of children. As no difference between the two residential groupings was found, we can therefore conclude that the two groups were similar with regard to HIV status, gender and age, therefore any differences between the two groups in motor performance may be attributable to residential situation.

The ages of the children ranged from three to six years at the beginning of the study (baseline) and at six-month follow-up and no difference existed between the ages of the children with HIV and those without HIV. Similarly no differences existed with regard to gender.

As mentioned in the literature review, children can show different rates of disease progression. One group classified as "fast progressors" develop serious illness early in their lives (i.e. 12-24 months) and did not live more than a year [74] before the government roll-out programme of ARVT was implemented. The children in this study were therefore either slow progressors (where 80% have a slower rate of disease progression) and may only show signs and symptoms on reaching school-going age or were placed on ARVT early enough to prevent death [42]. Studies have also indicated that children are now continuing to live longer with their life expectancies increasing annually and that the early use of combination therapy in infected infants and children is greatly encouraged [42 75 76].

In the results it was found that no association existed between HIV and gender and there were an equal number of girls and boys in each group. This distribution is similar to other studies on HIV in children where an equal number of boys and girls were included in the studies. For example, in a study on children with HIV in

Brazil, equal numbers of boys and girls were assessed with neurodevelopmental testing and no preponderance of either gender was found [35]. This is in contrast to other conditions, such as cerebral palsy in which boys are over represented. More males and females have been shown to report more disability [77].
The children recruited appeared to be representative of children with HIV who have been orphaned or abandoned in Cape Town.

5.2.2 Care-giving environment

Many children in the study were placed into foster care from a very young age and were placed directly from the institutions they were resident in initially following the death or abandonment by one or both parents. This meant that very few had had the experience of living with their natural parents and families before institutionalisation and fostering.

Another noteworthy finding was that the large percentage of children in foster care were cared for by the elderly or older members of the various communities and that the mean age of the foster mothers was almost 50 years old. The limited number of people prepared to foster children, the increase in the number of single parent households due to the impact of the migrant labour system and parents leaving to work or parents having difficulty coping with raising their children [78] might explain this finding. In discussion with foster parents, the impression was gained that several of the parents had intended to provide relief care or emergency care for abandoned children from a young age rather than permanently care for the children. This phenomenon (of elderly persons caring for young children) is common in South Africa where the progression and spread of the HIV/AIDS epidemic has led to an increase in the grandparent headed households [79] and this is predicted to rise.

The foster parents were not well educated and many were unemployed and relied on government grants to supplement their income, similar to other members of the

community in that many of the elderly similarly rely on government to supplement their income [9], to support their children and the household.

Four foster mothers were caring for more than one foster child and others cared for their own children or grandchildren [80] and consequently those who were prepared to foster, may become overloaded. Elderly, unemployed parents who are caring for several children may provide excellent care for the child, but they may overlook or may not have known the importance of stimulation and play in the development of children at a young age [9].

A great concern is the growing orphan crisis in Southern Africa and the fact that communities may soon be unable to absorb all children who require placement [80]. Social workers co-ordinated the process of fostering and institutionalisation but the increase in numbers is placing an increasing strain on services. There are a limited number of social workers and finding suitable parents is time consuming. In addition there is a lack of availability of suitable foster parents. (KV, Social Worker, personal communication, 2006).

In summary, it would appear that the foster caregivers might not be in a position to provide adequate developmental stimulation and the effect of HIV on development might be compounded by a lack of adequate stimulation in the home environment.

5.2.3 Medical condition

It was expected that the children with HIV would present with continuing opportunistic infections as, prior to the introduction of ARVT, opportunistic infections and hospital admissions were very common in children with HIV [33 81]. Many HIV positive children have been reported to suffer from fever for prolonged periods (longer than one month), loss of weight and failure to thrive, stunted growth and developmental delay, coughing with lower respiratory tract infections, lethargy and hepatosplenomegaly [82]. In fact, although many of the children reported serious

illnesses at some stage of their lives prior to testing, none of the children experienced any serious illness at the time of testing and none of them were ill as a result of opportunistic infections for the duration of the study. No deaths occurred for the duration of the study and only one HIV negative child had been admitted to hospital but this was as a result of parental neglect and not related to his status.

The improved health status of the infected children is likely to have been due to the early administration of ARVT as all the children who were HIV positive were receiving ARVT and none of the children had been on treatment for less than five months. The fact that the health status of all the children was good implies that the decreased scores for their development obtained on the PDMS II were unlikely to be due to current illness and /or recent hospital admissions. A study in Uganda, reported that treatment on ARVT for six months or longer resulted in increased longevity and an improved health status [83] .

Similarly, other paediatric studies have shown that the use of ARVT has resulted in an improvement in the immune systems [42 45]. All children were receiving ARVT. This could be attributed to improved service delivery as the government roll out programme had commenced in April 2004 to increase the amount of children and adults in developing countries to access expensive treatments [84]. Unfortunately, it was not possible to collect CD4 cell counts in the course of the study and therefore the immune systems of the children were not directly monitored.

Most children had tuberculosis (TB) during some stage of their lives along with experiencing other diseases such as diarrhoea, ear infections and meningitis. This is to be expected in an environment in which TB is endemic. TB is a major health problem of the developing world with the highest rates of TB occurring in developing countries [85]. Almost one third of the population in the developing world was infected with TB while in 1999 it was thought that 8-10 million actively had TB while 3 million died of it each year [3] and the situation in developing areas of Cape Town is no different.

It has been demonstrated that non-adherence to medication is a common problem when treating children [86]. Many children with TB have been hospitalised for extended periods because of non-compliance of medication, poverty and inability of rural communities to access medication appropriately. Several of these children are not returned to their parents and referred for placement either in foster homes or institutions (Gillian Ferguson, therapist at an Infectious Diseases Hospital, personal communication, 2007). Although not specifically asked in this study, it is likely that the same factors leading to hospitalisation for treatment e.g. inability of parents to provide a stable family environment, neglect, alcohol and drug abuse and death of parents would result in admission to long term residential care.

5.2.4 Influence of ARVT

An unexpected finding was that the developmental performance of the children, in particular the TMQ, was not predicted by the length of time the children had been on antiretroviral therapy or the age at which treatment was started. This finding was not expected as much of the literature reviewed shows that ARVT medication improves neurological outcomes and overall function [44 46 87-89].

The findings of the current study are however supported by some other research. One study found that ARVT (Zidovudine) had a limited benefit if neurological symptoms started after the second year of life [90]. It should be noted that this study was conducted in 1996, and since then there have been major advances in treatments have occurred, including the use of vigorous combination therapy (ARVT). This is in agreement with an unpublished study conducted in Cape Town [24] where infants aged 0-42 months were tested using the BSID II to assess motor and mental delay. It was found that 66.7% of infected infants showed signs of motor delay and that the developmental performances of the infants were not influenced by being on ARVT medication for any length of time. A limitation of this study was that the follow-up period was limited to nine months.

The implication of the result of the current study is that while ARVT improved the overall health and body composition of the children, the effect of the virus on development persists, at least until six months after initiation of treatment. Consequently, additional intervention, such as infant stimulation or environmental enrichment, might be necessary to improve the developmental outcomes of the children. In addition, it can be queried whether ARVT is commenced early enough in the current treatment protocols, as it would appear that the developmental delay is an early sign of HIV infection.

It should be noted however, that the impact of therapy might take longer than nine months to manifest itself and longer longitudinal studies are necessary to establish if the delay is permanent.

5.2.5 BMI

Each of the children's percentile BMI were calculated following the recording of height and weight measurements. Unfortunately no table was found to calculate the percentiles of the BMI normed for age and gender in South Africa. Consequently the Centre for Disease Control (CDC) calculator was used as this generated exact values, normed for gender and age. As the same calculator was used for all groups and these groups were compared to each other and not to the general populations, the fact that it was not normed on South African children was not regarded as a severe disadvantage. As expected the children with HIV had a significantly lower BMI percentile value than children without HIV [91]. However only one child fell below the 5th percentile and therefore fell in the category of being dangerously underweight according to the CDC scale.

In a European collaborative study, poor growth was observed in vertically infected children and differences in growth patterns continued and significantly increased with age between infected children and those exposed but not infected. After 2

years of age, weight differences changed dramatically. Even though both height and weight differed between the two groups, a greater difference had occurred in the weights of the children [92].

The impact of HIV in HIV infected individuals was further explored in other literature which suggests that differences in height and weight may occur between infected and uninfected but exposed children. Small differences in growth have been reported during the first four years of life, while a study conducted in Italy [91] reported that no substantial differences in BMI had occurred between the two groups within the first six months of life but that differences had occurred with a trend towards lower BMI for those infected early and higher BMI values for uninfected infants. In the South African context, differences in BMI were noted but may have been attributed to environmental factors and socio-economic status. HIV infected children had lower weights and were smaller in length than those uninfected [93].

An important finding of the study was that as the amount of time on ARVT increased, so did the percentile values for BMI. This is to be expected and is consistent with the literature. It was anticipated that children in the institutions would have a higher BMI as they may have had access to better nutrition over a prolonged period but this was not found to be the case.

With improved ARVT, an improvement in the health status of the individual may have contributed to an increased BMI.

5.2.6 Accessibility of health care and rehabilitation services

In the institutions, improved access to medical services, hospitals and medication occurred as there were trained professionals on site to monitor progress and refer the child if necessary. Transport was available to transport children free of charge as the need arose for medical follow up. In foster care it was the responsibility of

the caregivers to identify and act on ill-health of the child, paying for transport to and from the hospitals and community clinics to access medical services. This might have disadvantaged the children in foster care.

5.2.7 Support services

While the national guidelines for home and community care advocates essential services in the community, none of the foster care children had access to allied health professionals in their homes or at the community centres or health care centres for purposes of screening, assessment and intervention. These services were absent but are essential for early identification of motor, language and cognitive delay [37]. The government has identified home based care and community care of HIV infected persons as a key strategy to be implemented by 2005 [28]. However, from the findings of the current study, they may be seriously lacking in the service delivery that was to be implemented to children. An increase in the demand for health and other related services has occurred due to the increase in children infected with HIV/AIDS.

Community health care workers and social workers appear to have been at the forefront of co-ordinating the programmes in the Khayelitsha, Montana, Athlone, Manenberg areas, providing community outreach to the foster families, training for family support which constitutes one of the pillars of home based care. However, the inaccessibility of professional rehabilitation services to this group might be a factor leading to the decreased TMQ reported in the fostered children and the decreased TMQ of children with HIV. Drotar's study has found that as children may present with motor and neurological impairments, age appropriate early visual and social stimulation for development of HIV infected individuals is essential [94].

5.3 Factors related to development - HIV status

As anticipated the HIV status of the children was an important variable related to their motor performance.

5.3.1 Children without HIV

Developmental delay has been described as a 20%-25% or greater discrepancy between a child's chronological age and developmental age in one or more areas of the child's development [95 96].

There are many risk factors for poor developmental outcome. These include HIV status of the children, poor socio-economic status of families, parental educational levels and nutritional deficits [97], prenatal drug exposure, birth complications, stress and chronic illness [98].

The mean value of the TMQ in the children without HIV was 95 (SD=11.8) and only one of the children scored less than 75% of the expected TMQ value. It can be concluded that the majority of this group did not show developmental delay. This is in contrast to a study of healthy children living in a similarly deprived area of Cape Town [99]. They tested 85 healthy infants ranging in age from one to 36 months using the Bayley Scales of Infant Development II and reported a mean developmental quotient of 92 (SD=13.9) and that 18% (15 out of 85 children) scored below 75%. They concluded that the children in their sample were scoring lower than the norming sample and that the reasons for this were likely to be multifactorial, including the influence of a poorly resourced environment. The discrepancy between the current study and Ferguson and Jelsma might be due to several reasons. The ages of the children were different and older children might have had the opportunity to bridge the gap between the chronological age and the developmental

age due to possible changes that may have occurred in the environment. One reason that delay was so prevalent might be that, due to ethical and practical considerations, the children in the study were not tested for HIV, although children with any history of recurrent illness were excluded. As the prevalence of HIV in the community under study is so high, there may have been undiagnosed cases of HIV in the so called "healthy" children.

In contrast, all the children in the current study had been tested and it was unlikely that there were any children with HIV in the "healthy" sample. In addition they had attended crèches or play groups and their results are comparable to those of a smaller unpublished study which reported that children from the same area who attended preschool scored within normal limits on the PDMS II. Twenty four participants aged 48-72 months were tested at a crèche in Khayelitsha, Cape Town, and their findings reported that the mean and standard deviation of the children's motor quotient were similar to those of the norming sample. This indicated the children were performing at the same developmental level [73].

Another reason for the discrepancy in findings could be the use of the PDMS II compared to the BSID II. Ferguson and Jelsma suggest that the developmental testing scales might not have been appropriate for children in deprived areas of South Africa and might have underestimated the motor performance of the subjects. It might be that the norms of the PDMS II are more suited to South African children than those of the BSID II.

5.3.2 Children with HIV

Various Neurodevelopmental studies in Africa and across the globe suggest that children with HIV tend to present with cognitive and motor developmental delay and these delays may vary across the HIV infected population. The severity of the delay may vary from mild developmental delay where children fail to achieve milestones early in their lives to severe neurological impairment with multiple

handicaps [3 28 94 100]. HIV damages the developing brain and CNS involvement is common. Delay in developmental milestones may be the first presenting symptom [35] of the disease. In this study, the findings were similar in that seven of the children with HIV were classified as developmentally delayed and no child achieved a score of more than 100. However, the amount of delay was not as great as expected. Ferguson and Jelsma, for example reported a larger proportion of children with HIV who displayed moderate or severe motor delay in her sample of South African children. However their study was done during the intermediate stage between no ARVT being available and it gradually becoming universally accessible. In addition, the children were younger and were recruited through hospitals and might have been more severely ill [24]. The children in this study sample had all had access to adequate medical care and all had been on ARVT for no less than five months. In addition, the children in Ferguson and Jelsma's study were cared for in many cases by their natural mothers who were themselves ill and unable to access ARVT at that point in history. Further discussion on the reasons for the relatively better functioning are discussed below under the influence of residential setting.

As other studies using the PDMS II have reported a greater delay in the FMQ, it was surprising that the current study found that the FMQ tended towards being significantly greater than the GMQ. The current finding might be explained as gross motor skills depended on the ability of the children to use large muscle groups which incorporated strength for task execution [21]. In children with HIV who are malnourished and have a low BMI, it might be expected that the Gross Motor Function (GMF) might be decreased due to diminished energy expenditure. However almost all the children in this study fell within the norms of BMI and should not have shown relatively more delay in this area of functioning. Fine motor activity depended on the ability to perform precise movement co-ordination and included elements of hand eye, co-ordination and that of manual dexterity which required increased concentration [21]. As Fine Motor Function (FMF) is related to practice and opportunities to use the upper limb in skilled tasks, it might be that the

children in this study were subjected to more play stimulation than children raised by natural parents, who, as mentioned above, might be ill themselves.

The implication of these findings might be that the environment exerts a considerable influence on the abilities of children, even those with HIV. This is discussed in more depth below.

5.4 Factors relating to development - care-giving environment

5.4.1 Introduction

One of the primary aims of the study was to determine the influence of living environment, i.e. foster care or institutionalisation, on the motor development of the children. It was found that in all the children fostering was initially associated with an increased delay in development, particularly in the domain of FMQ. This difference decreased over time until at six months there was no significant difference between the scores in both settings. This finding was born out by the regression analysis which identified residential setting as being predictive of TMQ at baseline, but not at six months. Although the difference lost significance over time, children in the institutions consistently scored higher than those in foster care.

The scores of all children increased significantly between baseline and six months and indicated that children improved on performance.

5.4.2 Effect of institutionalisation

5.4.2.1 Policy regarding institutional care

In South Africa, and the rest of the world institutionalisation is strongly discouraged and many developed countries have gradually attempted to disregard institutional care and favour adoption or foster care [101]. This was necessary to limit the need for expensive institutional care, to distribute and share the cost of care at various service levels within the system and spread available resources. While a variety of reasons exist why the home based model of care is necessary, a large percentage of children in South Africa are still cared for in orphanages/ institutions [102]. This is due to the growing need to accommodate the orphaned and vulnerable children as a result of HIV/AIDS with a corresponding collapse of kinship care/fostering due to parents dying, suffering, ill-health and poverty. In 2004, in South Africa, 29000 children are housed in approximately 169 registered children's homes. These facilities have opened their doors to orphan and vulnerable children and with the assistance of local and international contributions, many of these do not receive a government subsidy [102].

Although, institutionalisation is necessary it may be severely detrimental to the child. Richter identifies several disadvantages including that residential care settings damage the child's development and social adjustment; they are an expensive method of providing care as there is a serious lack of funding to support these institutions, and that families may reject kin [102].

5.4.2.2 Advantage of institutional care found in this study

In contrast, the present study results demonstrated a positive effect of residential care and found that children with HIV were performing better in institutions, at least in the areas of fine motor development. The authors can only speculate as to

why this should be so. The improved FMQ of the institutionalised children may be attributed to a lack of stimulation in the foster homes due to some of the following factors:

- Although not asked in the questionnaire, there was obvious instability in the foster home in two cases, as the foster-parents were unable to cope and placed them back into institutions, before the second assessment.
- Poor socio-economic circumstances of carers was evident in that many depended on foster care grants to sustain families with no formal employment
- Advanced age of the care-givers and the burden on the elderly.
- Exposure to different cultural influences through interaction with volunteers, therapists and staff might have resulted in an increased level of stimulation for the institutionalised children. In the institutions included in this study, the children received constant stimulation and interaction with persons from various other communities and cultures. For example, there were at least five or six students from other countries doing volunteer work with the children at the various institutions. In addition, the institutionalized children had more access to therapy and this added stimulation is likely to have had a favourable impact on their fine motor performance. It appeared that this group was more familiar with the different types of activities presented in the test and several of the fostered children were not used to the various activities as culturally they may not have been exposed to these activities.
- Children in institutions were exposed to more space to explore their environment. All institutions visited were well equipped with outdoor equipment including playing frames, climbing equipment and a safe place to play. In the communities, a serious lack of resources exists with regards to playing space for the children, parks to play in and safe areas to play.

5.4.2.3 Discussion on advantages of different types of residential care

Although, the preferred model of care by Africans is community based care as it keeps the child in the family environment, in their own village and tribe and strengthens their community [103], this may not be ideal under conditions of poverty and severe resource constraints. A finding similar to this study, i.e. that foster-care might disadvantage children, was reported in a review article reviewing various literature on care settings. It was found that fostered children were taken in by poorer families Kenya who needed additional income. In West Africa, it was found that fostered children had higher mortality rates as, similar to Kenya, it was the poorer families caring for these children and as a result of poor care, malnutrition and limited access to modern medicine, they were not thriving in their environment [104]. Also, a study looking at cocaine exposed infants found that the development of these children at later ages found that children in kinship care attained lower scores than children living with their biological mothers. They were tested using the Bayley Scales of Infant development. Also, it has been stated that children in kinship care received intervention at a later stage or only after they had developed more severe impairments [105].

The study results are inconsistent with a study conducted in Iraqi Kurdistan in that while similarities and differences occur with the development of children in the two orphan care settings, the foster care revealed better outcomes over time [14]. The results are also incompatible with the suggestion that long term fostering necessarily offers children security, a loving family environment and a close substitute of parental relationships while institutional care is thought to provide unstable caregiver relationships, lack of a sense of belonging and children may be missing out on the family unit [106] [107]. It was found in the present study that two children had been placed back into institutions following illness of the foster parents and a further two children suffered abuse /neglect when they were transferred from institutions to the care of their foster parents. The role of the social workers in monitoring the situation of fostered children is clearly essential.

A possible disadvantage of children being institutionalised as cited in many articles is that the high turnover of staff may have led to limited amounts of emotional bonds between children and caregivers compared to those in foster care. However the caregivers in these institutions were young or middle aged individuals who were involved in the daily stimulation programmes of the children. In addition, although not specifically monitored, there were approximately five to six volunteers who worked with the institutionalised children during this time. These volunteers were regulated by the placement agencies as a volunteer programme. Assistance from international communities is necessary to provide aid for assisting poorer households to adequately care for orphans [80]. In Uganda a British charity instigated and assisted with the establishment of a home based care programme for individuals in 2001 [81]. A successful programme was set up with a multidisciplinary team and with this support, there was improved monitoring of the children in their communities along with physical, psychological, emotional, social and economic support [81]. It might be useful that when volunteers coming to work with children with HIV in Cape Town are not only placed in the institutions but also, as in Uganda, within the community to work with foster parents.

At baseline, all children performed better in the institutional setting with regard to FMQ and TMQ ability. However, this difference diminished considerably and six months later, residential setting was no longer a predictor of TMQ. This is discussed under the following section, Change over time.

5.5 *Factors relating to development – change over time*

A striking finding of the study was that a significant improvement was noted in the performance of the entire participant group from baseline to six months. There may have been some influence of the advice given by the researcher to care-givers of children with developmental delay, but this was unavoidable due to ethical

considerations. It is impossible to determine whether the care-givers did take the advice and whether improvement could have been as a result of this single encounter. It is unlikely that the improvement was a function of maturation or of the measurement scale as no correlation between age and TMQ was found. This is borne out by a study using the Peabody Developmental motor scales which demonstrated that scores on the PDMS II decreased over time by documenting the longitudinal development of high risk children at 18 months, three and five years. It was found that over time, the 5 year olds experienced a higher prevalence of gross motor deficit at school going age. While the authors were unable to explain this result they assumed that it may have been attributed to the increasingly challenging nature of the gross motor skills that were expected at that stage of the PDMS II [108].

Although scores on fine motor development, on the other hand, have been found to remain stable over time, from two to five years of age, there is no report of improved performance with time. In various studies testing low to very low birth weight children and it was found that delays were detected as early as two years of age and that these deficits continued until the age of five years [109 110].

Exposure to the test at baseline might have led to a learning effect which resulted in improved performance on the second test. However this is not likely as the tests were six months apart. Other factors that may have contributed to the possible improvement in performance over the six months of the study include a sustained stable living environment for the majority of children, regular nutritional meals, regular follow up and monitoring of health status, improved compliance with medication and improved access to health care.

In addition, the amount of stimulation afforded to the children in foster care was greatly increased over the course of the study. Social workers and community field workers combined resources and provided foster care parents with emotional support and training on coping with a foster care child and a child infected with HIV/AIDS.

It would appear that the motor function of the children in this study was amenable to change through changes in environmental factors. This is an important finding as it supports the view that developmental performance in children can be improved significantly by stimulation and the interaction with people in the environment. While many discussions focus on the nature (maturationist view) versus nurture (constructivist view) debate, it would appear that in this study, the influence of environmental change lead to significant improvement in performance, a finding which supports the constructivist view that maintains that the environment and the people who interact with children shape who they are (Hunt, 1969 as quoted by Elkind and Flavell) [111]. This is supported by a study conducted in Brazil where it was found that in typically developing children the social environment greatly influenced motor development. The study highlighted, amongst other factors, the need for recreational activities and a safe and opportunity rich environment. Intervention aimed at enriching the social environment of the orphaned child is therefore likely to be effective.

5.6 Relationship between TMQ and other variables

5.6.1 Gender

No association existed between gender and TMQ, with males and females performing similarly, which accords with other studies on typically developing children, in which males and females were reported to develop at the same rate. A Greek study performed on 5 year old typically developing children revealed that there were no significant gender differences in the performance of gross motor tasks [112]. Similarly, an unpublished undergraduate study undertaken at the University of Cape Town found that gender did not impact on motor performance of a group of pre-school children in Khayelitsha. The assessment tool used was the same, i.e. PDMS II [73]. The current study found that no difference existed in the execution of

tasks amongst males and females with HIV and this is in agreement with a longitudinal study that indicated that there was no difference in the rate of the neurological decline between HIV positive males and females. [113].

5.6.2 Body Mass Index (BMI)

An unexpected and inexplicable result of this study showed that a negative correlation existed between the TMQ and the BMI in children with HIV, whereas no such correlation was found in the HIV negative group. It is difficult to speculate as to why this should have been found as a low BMI and failure to thrive are characteristics of children with HIV [20 114]. In a study testing 22 HIV infected infants, the study reported an association between linear growth and neurodevelopment in these infants compared to uninfected infants. Children with increased growth failure have the most cognitive and motor delay, with most of the growth failure being observed within the first six months of life and delays in neurodevelopment occurred and was noted by 12 months [100].

As so few children were categorised as having a low BMI (only one under the 5th percentile), it might be that the children were receiving adequate nutrition and that the ARVT was preventing opportunistic infections. This was borne out by the finding that there was a trend towards a significant correlation between time on ARVT and BMI. There was no variance in weight associated with the disease and the negative correlation might be a spurious, by chance finding [38].

Socio-economic factors did not emerge as being predictive of performance, when entered into the regression analysis to predict performance. However, residential setting and the child's HIV status were predictive of performance at baseline for all children and at six months for children with HIV. The multivariate analysis is supported by the univariate analyses, the results of which have been discussed above.

It would appear that all children improved over time and that the influence of residential setting diminished in the whole group. However, it appears that children with HIV in foster care remained at a disadvantage and that this group should be targeted specifically to receive additional stimulation.

5.7 Methodological issues and limitations of the study

5.7.1 Research Design

The sample was a sample of convenience as it is clearly unethical and undesirable to design a study in which children are randomly assigned to foster or institutional care. As such, causality cannot be proved. The study cannot prove that children in foster-care performed worse because they are in foster care. There may be other confounding variables, e.g. the children who were doing worst in the institutions were preferentially chosen to be fostered. However, the study can say that, at this stage it appears that the children in foster care with HIV are the most in need of developmental stimulation.

A longitudinal study design was used and was found to be the most appropriate study design when documenting development and change of development over time. It is conceded that the giving of advice regarding stimulation to the care-givers of children with developmental delay might have resulted in improved performance at six months. However, this was regarded as being an ethical imperative.

Attrition is one of the greatest problems associated with longitudinal studies, but various researchers have advocated the use of the longitudinal studies with regard to the ability to document change over time [65 115]. However, attrition in longitudinal studies leads to a decrease in the number of participants and thus a decrease in the sample size [67]. This is an important consideration as the results from a small sample

size may not be sufficient to generalize results to a general, global population. The attrition in this study was about 20%, which is high, but not as high as the 58% attrition at six months reported in a similar study in Cape Town on younger children with HIV cared for by their mothers [24].

In Cape Town, school/ centres take an extended break over Christmas. It was therefore difficult to continue data collection as children accompanied parents to the Eastern Cape. Any future longitudinal research to be undertaken in these areas should consider the disruption and try to schedule data collection outside of extended breaks (December and June/July school holidays).

5.7.2 Sample

A large number of children at the various institutions and in foster care were either below the age of two years or above eight years of age. This therefore limited the sample to a total of 44 participants. As the sample size was smaller than anticipated, the study might not have had adequate power to detect differences between the groups. Community group establishments caring for fostered children housed children older than seven who were of school going age and were able to care for themselves with minimal assistance. The results of the study should be generalised with caution to the entire population within the institution setting and the foster care setting and may only apply to the group tested.

5.7.3 Access to information and missing data

The researcher was unable to access medical information including the biological mother status and prenatal history of the fostered children as this information was not given to foster parents. In the institutions, each child did have a folder but the information regarding birth history was limited. Similarly there was little medical information and it was decided that a detailed study of the medical condition of the child (e.g. CD4 counts) was beyond the scope of this study. Reasons for admission

to the institutions of specific children were not available, but the most common causes were identified by the staff.

The researcher did not document all the different sources of social support and stimulation which the children received, such as the input of volunteers and training of foster parents and caregivers. This information may prove useful when focussing on these specific areas and planning intervention.

5.7.4 Use of the PDMS II

The PDMS II is a useful tool to assess the motor abilities of children. It provides a comprehensive range of a motor activities programme for all ages along with motor programmes to assist those who are delayed or have difficulty executing these tasks.

One of the major problems with the test item was that the children were unfamiliar with various activities presented to them and that it may have been the first time that they had come across the various items.

The principal researcher conducted all baseline and follow-up testing to allow consistency during the research and testing stages. All children at the follow-up testing session had improved in their developmental performance. As children were given the opportunity to perform the tasks more than once during the initial testing phase, a problem that may have occurred was that they had learned the activity, practiced it and improved with time due to learning.

The PDMS II assessment fails to describe in detail the quality and components of movements when activities were performed. Overall posture, the use of compensatory movement patterns and the influence of these on the quality of activity/quality of movements are not considered. Children may show improvement in these and unless their function has improved, the PDMS II will not indicate improvement.

However, the results of the PDMS II indicate that children in foster care, and particularly those with HIV, perform worse in the area of fine motor skills. The difference decreased over the course of the study, as the level of stimulation to the foster care children increased, which implies that performance on the PDMS II is influenced by changes in the environment. This might indicate that the fostered children, especially those with HIV, need more stimulation and that this group need to be targeted in future. This need is also likely to be evident amongst children with HIV living with their natural parents, or being cared for by relatives as the socio-economic setting is most probably similar. Foster children were tested in a neutral, unfamiliar environment compared to those in the institutions. This may have affected the outcome at baseline.

The results of the study indicate that HIV children are significantly delayed compared to their HIV negative counterparts, particularly with regard to gross motor function. However, all children with HIV received ARVT and appeared to be thriving with regard to their general health and BMI. However, the institution of ARVT was not found to mitigate against the developmental delay (at least up until six months after use). It would therefore appear that the developmental delay might be due to primary damage to the nervous system which might take place even before the onset of opportunistic infections. This delay seems to persist even when these infections are prevented by adequate medication. The possibility that universal access to ARVT will not result in eradicating developmental delay needs to be researched further. Ferguson suggests that developmental delay be regarded as a defining symptom of HIV and that, on its own, warrants the initiation of treatment [24]. Early institution of ARVT might prevent or decrease this delay. However, if the delay cannot be prevented or treated with ARVT, then appropriate therapeutic intervention becomes essential.

6.1 Recommendations

The focus of this study was on the impact of institutionalisation or fostering on motor development. The impact of institutionalisation or fostering on other aspects of the child's development, such as emotional or language development was not examined. No conclusion or recommendation can therefore be made with regard to the desirability of one or the other residential setting. The intention of this section is to make suggestions with regard to how children can receive equivalent amounts of stimulation in either setting.

In order to facilitate family cohesiveness and parental coping abilities, it is important for community projects and government concerns to establish adequate support structures for families caring for a child with HIV who displays developmental and cognitive delays. Children with chronic illnesses, such as HIV, require various care and services at various stages of the disease. It may be difficult to cope with a chronic disease and therefore parental support, family and community support is vital to facilitate a positive child, family and future developmental outcomes.

- There should be a strengthening of the support programmes within the communities to ensure that all fostered children, particularly those with HIV, received adequate stimulation of development.
- This programme should be made available to all children with HIV living in the community, not only those living in foster care.
- The results of this research may be used in the formulation of policy with regard to improving the infrastructure within deprived communities and those in areas where parents are classified within the low income bracket.

About one third of the children with HIV demonstrated considerable delay. As early identification of developmental problems is critical to optimizing learning, special education intervention and appropriate development of language, it is recommended that:

- Early identification of delay and follow up by a multidisciplinary team and a neurological examination is necessary who may experience problems. A multidisciplinary approach to treatment is necessary to ensure screening, identification and intervention.
- Rehabilitation professionals should use standardized tests for the identification of delay in children at risk and for the monitoring of progress.

Although no causality was proved in the study, it appears that increased stimulation in the different settings was associated with improved performance. It is therefore recommended that specific intervention programmes, including stimulation of fine motor activity for children in foster care and gross motor activity for children with HIV be developed and instituted. NGO's should be encouraged to recruit volunteers to work with foster parents and their children, as well as with the institutionalized children.

The implication of the number of children with developmental delay is that the prevalence of developmental delay is high in this cohort of children and as more children begin to access the educational system, educators need to be aware of the possibility of special educational needs of the learners.

The study also identified areas in which further research is required. It is recommended that the following areas need to be studied further.

- The long term impact of ARVT needs to be established by means of a large, longitudinal study. Similarly, the optimal stage and age at which this should be initiated needs to be established.

- The impact of care settings and HIV status on the school performance of children will need to be examined. In addition the impact of development motor development on schooling also needs to be established. While children are admitted to institutions and foster care at a vulnerable age, it is important that these issues are considered when children start their schooling career.

- Future research is recommended to identify and establish appropriate methods of rehabilitation service delivery in the various communities and must be conducted to determine the impact delayed milestones has on school performance.

7 Conclusion

In the wake of the AIDS pandemic, the most vulnerable section of our population faces many challenges. Orphaned and abandoned children clearly need to rely on public structures to give them the support that they need. It is incumbent on us all to ensure that adequate resources are allocated to improving the lives of our children and thus safeguarding the future of our communities.

This study has examined the impact of residential setting on the motor development of children with HIV. Although the results are in some way encouraging there is no information on those children who are not in some form of care but who either live on the streets or struggle to keep families together without the presence of adults. In addition, there is still a need to provide additional support to those who have opened their homes to these children.

It is the government's responsibility along with each community and individual to invest in our children and provide the best possible services in time, commitment and policy. If we fail to provide the best possible health and rehabilitative service

and appropriate placements that the available resources allow us, we place the future of our children at great risk. In the words of Haroon Saloojee and Avy Violari [29] **"tomorrow's children will judge our resolve or inaction"**

Will this generation be found wanting?

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APPENDIX I: Demographic Questionnaire

Foster Care Questionnaire

Community Centre/Foster Care Agency:

Demographic Information

Child

Name _____ Surname _____

DOB _____ Gender M F

Gest.age _____wks Birth wt _____

Road to Health Chart: Y N

Height: _____ Weight: _____

HIV Status: _____ Mode of Transmission:_____

Has your child ever been diagnosed with any of these conditions?

Condition	Y/N	Date diagnosed
TB		
Pneumonia		
Gastro		
Ear infections		
Meningitis		
Seizures		

Is your child on any medication? Y N

If yes, for how long? _____

Details of medication? _____

_____

_____

Has your child been hospitalised in the past 3 months? Y N

If yes, how many times? 1 2 3 4 5 6

If Y, what was the diagnosis? _____

If Y, how many days in hospital _____

Does the child attend crèche / school? Y N

.....

Mother/caregiver/foster mother

Date of Birth _____

Hospital Folder number (of mother) _____

Relationship to child _____

If not mom, where is mom? _____

Highest Education level Grade _____

How long has your child been in your care? _____

Where do you get your income?

I am employed ☐

I sell things ☐

I receive a grant –foster care grant? ☐ Other_____

I receive donations ☐

Spouse/partner works ☐

A relative/friend supports me ☐

Other ☐

Type of house: Formal Informal

Water: Inside Outside

Electricity: Y N

No of people in house _____

No of rooms (excl kitchen and bathroom) _____

Does the child's father live with you? Y N

Does he give you financial support? Y N

How many children do you have? _____

Support Services

What is the name of your nearest clinic? _____

How far must you walk to get there? _____

Where do you get your child's medication? _____

Does anyone visit your home to find out how you are coping? Y N

If Y, where are they from? _____

Institution Questionnaire

Name of Institution:

Demographic Information

Child

Name _____ Surname _____

DOB/Age _____ Gender M F

Gest.age _____wks Birth wt _____

Road to Health Chart: Y N

Height: _____ Weight: _____

HIV Status: _____ Mode of Transmission:_____

.....

Medical History

Has the child/resident ever been diagnosed with any of these conditions?

Condition	Y/N	Date diagnosed
TB		
Pneumonia		
Gastro		
Ear infections		
Meningitis		
Seizures		

Is the child on any medication? Y N

If yes, for how long? _____

Details of medication? _____

_____

_____

Has the child/resident been hospitalised in the past 3 months? Y N

If Y, how many times? 1 2 3 4 5 6

If Y, what was the diagnosis? _____

If Y, how many days in hospital _____

Does the child attend crèche/school? Y N

If the child is currently on antiretroviral therapy, please answer the following questions?

At which hospital is the child followed up? _____

Where are medication received? _____

.....

Daily Activities

Programme of the institution

Is there a set programme whereby the institution is run? Y N

If Y, at what times are the children served:

Breakfast? _____ Lunch? _____ Dinner? _____

Do the children have specific play time / activity time? Y N

If Y, at what times do the children have activity/ playtime? _____

.....

Therapeutic Intervention

Do the children receive:

Physiotherapy? Y N

For how long? _____

Occupational Therapy? Y N

For how long? _____

Speech Therapy? Y N

For how long? _____

Other? Please specify _____

APPENDIX II: Informed Consent Form

University of Cape Town
School of Health and Rehabilitation Sciences
Division of Physiotherapy

Consent form

Title of Study:	Assessment of the motor development of children with and without HIV, living in institutions and in foster care.	
Investigator:	Nailah Davids	BSc Physiotherapy
	Contact:	083 357 4858
Supervisor:	Dr Jennifer Jelsma	PhD Physiotherapy
	Contact:	(021) 406 6404

- ☐ I have been asked to give permission for my child/resident to participate because he/she was fostered by me / placed in an institution
- ☐ This research is to help healthcare workers to understand the development of children who are HIV positive
- ☐ I understand that I will not be given anything extra for participating in this study
- ☐ If my child is diagnosed with a developmental problem, the researcher may refer my child for further investigation if appropriate
- ☐ If any sign of neglect or abuse is detected, and it is in the best interest of the child and family, the researcher will refer the child to Social services or your social worker for follow up.
- ☐ Participation in this study will not have any other benefit to me
- ☐ Neither my child nor I will be harmed in any way during the study
- ☐ The researcher will spend about 45 - 60 minutes with us for the first visit and six months later while she conducts the tests to assess my child's development
- ☐ They have explained that if I do not attend on my given appointment day, they will contact me to attend the clinic.
- ☐ The researchers may contact me at home to arrange to assess my child in his home environment during the course of the study
- ☐ I know that my child does not have to take part in these tests and that I can stop the test at any time and withdraw from the study
- ☐ I understand that only the researcher will know what the results of the tests are and that all information requested from me will remain confidential.
- ☐ I have the right to refuse that information be shared with my doctor
- ☐ If I refuse to participate in this study it will not affect the treatment and medication given to me by the doctors

I acknowledge that I am the child's legal guardian. I hereby give consent for him/her to participate in this study

Signed _____ Date_____

Interviewer _____ Date_____

Witness/Translator _____ Date_____

APPENDIX III: General Information for parents and institutions

University of Cape Town
School of Health and Rehabilitation Sciences
Division of Physiotherapy

Information Sheet for foster parents

My name is Nailah Davids (Student number: DVD NAI 002) and I am registered as a student at the University of Cape Town for a Masters Degree in Physiotherapy. I am doing this research as part of my degree.

Purpose of the study:

A large number of orphans have been created as a result of HIV/AIDS and communities are finding it difficult to cope with the amount of children. Many institutions and places of care have opened their doors to house those children affected and infected by HIV/AIDS. Community outreach programmes have also been established as a means of supporting those in the community that are currently caring for these children. Government support is provided in the form of foster care grants and community programmes to foster parents but accessing these have also been difficult for those who are unaware of the support.

My intention for the research project is assessing and comparing the motor development of children living with and without HIV/AIDS in foster care.
The results of my study may contribute to identifying which areas of development are delayed due to HIV infection and the care facility children thrive in. This may lead to identifying information that may contribute to the development of policies regarding the care of these children and the appropriate placement of orphans and vulnerable children.

Why have you been chosen?

You have been chosen as you are one of many parents who have fostered a child and is providing care for your child.

What will be expected of you and your child?

You will need to sign a consent form to allow us to work with you and your child. You will be expected to complete a questionnaire regarding your child's health and development before testing starts. You will need to allow the researchers to carry out testing on your child which will take 45-60 minutes at the community centre identified by the researchers.

What will the benefits be of taking part?

Your child may benefit from referral to various services if the need arises. Advice regarding your child will be given if the researchers find that your child is in need of advice regarding stimulation.

Risks:

Testing may take 45-60 minutes per session. There is the risk that your child may get tired during testing. The well being of the child will be considered at all times and testing will be stopped if the child becomes tired or distressed. Researchers will ensure all safety procedures are in place before testing begins and take steps to ensure that the child is protected as far as possible. There is the possibility of you being distressed if your child is not progressing. You will also need to disclose the HIV status of your child if you know it.

Payment:

Neither you nor your child will be paid to take part in the study. However, R50.00 will be given to you for each visit to help you with transport costs.

Who will know the results of my child's tests?

The Ethics Committee and the researchers will be the only people who would know the results of the tests. If the researches think that your child will benefit from treatment, we will refer your child for treatment and, with your permission, let the therapist know the results of the tests.

Do I have to take part?

Participation in the study is voluntary. You may withdraw from the study at any time and without giving the researchers any reason for doing so. It will make no difference to any of the services that your child receives at present.

Who do I contact?

Nailah Davids 083 357 4858

Thank you to all for participating in the study.

University of Cape Town
School of Health and Rehabilitation Sciences
Division of Physiotherapy

Information Sheet for institutions

My name is Nailah Davids (Student number: DVD NAI 002) and I am registered as a student at the University of Cape Town for a Masters Degree in Physiotherapy. I am doing this research as part of my degree.

Purpose of the study:

A large number of orphans have been created as a result of the HIV/AIDS pandemic and communities are finding it increasingly difficult to cope with the amount of children due to parents dying of AIDS. Many institutions and places of care have opened their doors to house those children affected and infected by HIV/AIDS. Community outreach programmes have also been established as a means of supporting those in the community that are currently caring for these children. Government support is provided in the form of foster care grants and community programmes to foster parents but accessing these have also been difficult for those who are unaware of the support.

My intention for the research project is based on assessing and comparing the motor development of children living with and without HIV/AIDS. I have chosen to use a sample of children aged 3-6 years from institutions in Cape Town and children who have been fostered, currently living in the community. My intention is also to compare the developmental progress between these groups and to possibly identify the system of care that is most appropriate for these children and their development. Various types of care are available to children in need of care. Every child has the right to an environment that is caring, safe and offers long-term stability.

The results of my study may contribute to identifying which areas of development are delayed due to HIV infection and the care facility children thrive in. This may lead to identifying information that may contribute to the development of policies regarding the care of these children and the appropriate placement of orphans and vulnerable children.

Why have you been chosen?

Your institution has been chosen as it is one of many institutions currently housing and caring for orphaned and vulnerable children that have been affected and infected by HIV/AIDS.

What will be expected of you and your child?

You will need to sign a consent form to allow the researchers to work with you and the child. You will be expected to complete a questionnaire regarding the child's health and development before testing starts. You will need to allow the researchers to carry out testing on your child which will take 45-60 minutes at the institution.

What will the benefits be of taking part?

The child may benefit from referral to various services if the need arises. Advice regarding the child will be given if the researchers find that the child is in need of advice regarding stimulation.

Risks:

Testing may take 45-60 minutes per session. There is the risk that the child may get tired during testing. The well being of the child will be considered at all times and testing will be stopped if the child becomes tired or distressed. Researchers will ensure all safety procedures are in place before testing begins and take steps to ensure that the child is protected as far as possible. There is the possibility of you being distressed if the child is not progressing. You will also need to disclose the HIV status of the child if you know it.

Payment:

Neither you nor the child will be paid to take part in the study. However, a donation in the form of toys to the children and the institution will be given at completion of the study.

Who will know the results of my child's tests?

The Ethics Committee and the researchers will be the only people who would know the results of the tests. If the researches think that the child will benefit from treatment, we will refer the child for treatment and, with your permission, let the therapist know the results of the tests.

Do I have to take part?

Participation in the study is voluntary. You may withdraw from the study at any time and without giving the researchers any reason for doing so. It will make no difference to any of the services that the child receives at present.

Who do I contact?

Nailah Davids 083 357 4858

Thank you to all for participating in the study.

APPENDIX IV: PDMS II Score Sheet

PDMS-2

Examiner Record Booklet

Peabody Developmental Motor Scales

Second Edition

Section I. Identifying Information

Child's Name _____ Female ☐ Male ☐

First Administration	Year	Month	Day
Date Tested	____	____	____
Date of Birth	____	____	____
Chronological Age	____	____	____
Prematurity Adjustment		— ____	— ____
Corrected Age	____	____	____
Age in Months		____	

Examiner's Name _____

Examiner's Title _____

Subtest Results

	Raw Score		Raw Score
Reflexes	____	Object Manipulation	____
Stationary	____	Grasping	____
Locomotion	____	Visual-Motor Integration	____

Second Administration	Year	Month	Day
Date Tested	____	____	____
Date of Birth	____	____	____
Chronological Age	____	____	____
Prematurity Adjustment		— ____	— ____
Corrected Age	____	____	____
Age in Months		____	

Examiner's Name _____

Examiner's Title _____

Subtest Results

	Raw Score		Raw Score
Reflexes	____	Object Manipulation	____
Stationary	____	Grasping	____
Locomotion	____	Visual-Motor Integration	____

Third Administration	Year	Month	Day
Date Tested	____	____	____
Date of Birth	____	____	____
Chronological Age	____	____	____
Prematurity Adjustment		— ____	— ____
Corrected Age	____	____	____
Age in Months		____	

Examiner's Name _____

Examiner's Title _____

Subtest Results

	Raw Score		Raw Score
Reflexes	____	Object Manipulation	____
Stationary	____	Grasping	____
Locomotion	____	Visual-Motor Integration	____

Fourth Administration	Year	Month	Day
Date Tested	____	____	____
Date of Birth	____	____	____
Chronological Age	____	____	____
Prematurity Adjustment		— ____	— ____
Corrected Age	____	____	____
Age in Months		____	

Examiner's Name _____

Examiner's Title _____

Subtest Results

	Raw Score		Raw Score
Reflexes	____	Object Manipulation	____
Stationary	____	Grasping	____
Locomotion	____	Visual-Motor Integration	____

5 6 7 8 9 07 06 05 04 03

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Section II: Record of Item Performance

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
Gross Motor Scales							
Reflexes							
1 Start: 1-11 months	2	WALKING REFLEX With hands around trunk, hold child in standing position (facing away). Tilt child slightly forward. Brush top of child's feet against edge of table, then hold child so feet are resting on table.	2 Lifts 1 foot, then the other, in forward walking movement within 3 seconds 1 Lifts 1 foot within 3 seconds 0 Feet and legs remain still				
2	4	POSITIONING REFLEX: Asymmetrical Tonic Neck Reflex (Integrated) *(Lying on back, head toward examiner)* Turn child's face so left cheek is parallel to surface. Hold his or her head in that position for 3 seconds and observe child's reaction. Repeat procedure to right side.	2 Does not move arms and legs as a result of head being turned 1 Arms and legs respond as described below, but can move arms and legs out of position while head is turned 0 Reflex still present [When face is turned left, left arm and leg extend while right arm and right leg flex. When face is turned right, right arm and right leg extend while left arm and left leg flex. Reflex disappears by 6 months.]				
3	6	LANDAU REACTION Hold child suspended horizontally, stomach toward floor, side toward you with your hands under his or her chest and stomach.	2 Raises head above horizontal plane, extends trunk, and symmetrically raises hips and legs into full extension 1 Extends head above plane and extends trunk but hips and legs remain below horizontal 0 Head and hips remain below horizontal				
4	6	PROTECTING REACTION—Forward [Either kneel on floor or stand facing table so when child is tilted forward, he or she can reach surface.] Hold child in suspended horizontal position, stomach parallel to floor, buttocks toward you, then quickly tilt child's head toward the surface.	2 Extends arms, straightens elbows, and bears weight on open palms 1 Extends arms or puts hands on surface, elbows bent, but doesn't bear weight 0 Fails to extend arms or put hands on surface				
5	6	PROTECTING REACTION—Side *(Sitting, back toward you)* With hands at hips, support child in sitting position, then quickly tilt child 45 degrees to one side.	2 Breaks fall by extending arm and supporting self with open palm for 2 seconds 1 Breaks fall by falling on forearm 0 Falls on side				
6	6	PROTECTING REACTION—Forward *(Sitting, back toward you)* With hands at hips, support child in sitting position, then quickly tilt child 45 degrees forward.	2 Breaks fall by extending one or both arms and supporting self with one or both open palms for 2 seconds 1 Extends one or both arms and falls forward 0 Fails to extend arms				
7	9	RIGHTING REACTION—Forward *(Sitting, back toward you)* Place your hands on child's shoulders and pull him or her backward 20 degrees from vertical. (Be prepared to catch child if no reaction occurs.)	2 Extends arms and head forward to recover balance and returns to upright sitting position 1 Extends arms forward and to floor to recover balance and returns to upright sitting position 0 Fails to extend arms or head forward				
8	10	PROTECTING REACTION—Backward *(Sitting, facing you)* Place your hands on child's chest and push gently and rapidly backward at least 45 degrees. (Have someone prepared to catch child or stop fall if no reaction occurs.)	2 Stops fall by extending arm(s) backward and supporting weight on open palm(s) 1 Rotates trunk to one side and extends arm but continues to fall 0 Fails to extend arms				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
		Stationary					
1 Start: 1–2 months	0	ROTATING HEAD *(Lying on stomach, head turned to side with cheek resting on surface; examiner out of eyesight)* Shake **rattle** 3 times behind child's head. Repeat procedure with opposite cheek resting on surface.	2 Lifts and turns head so opposite cheek touches surface (both sides) 1 Lifts and turns head so opposite cheek touches surface (1 side only) 0 Head remains as positioned				
2	0	ALIGNING TRUNK *(Sitting, facing you)* Support child in sitting position by holding his or her wrists and arms. Observe position of child's back.	2 Holds back in rounded position for 3 seconds 1 Holds back in rounded position for 1–2 seconds 0 Arches back immediately				
3	1	ALIGNING HEAD—Front *(Sitting, head hanging forward, back to you)* With hands around trunk, support child in sitting position. Observe head alignment in relation to trunk.	2 Holds head so that a 45-degree angle (or greater) exists between chin and chest 1 Holds head up slightly from chest 0 Chin touches chest				
4	1	ALIGNING HEAD—Back *(Lying on back, pulled to sitting)* Grasp child's hands and wrists and gently pull him or her to a sitting position. Observe head alignment during movement cycle and head position at end of cycle.	2 Holds head so that a 45-degree angle (or greater) exists between back of head and back 1 Holds head up slightly from back 0 Head touches back				
5 Start: 3 months	2	ALIGNING HEAD *(Lying on back, pulled to sitting)* Grasp child's hands and wrists and gently pull to a sitting position. Observe head alignment during movement cycle and head position at end of cycle.	2 Holds head in midline through 75%–100% of movement cycle 1 Holds head in midline through 50%–74% of movement cycle 0 Holds head in midline for less than 50% of cycle				
6	2	EXTENDING HEAD *(Held in a suspended vertical position with head toward ceiling, feet toward floor)* Pick child up (facing you) with your hands around trunk. Observe head alignment.	2 Raises head at midline and holds it in alignment for 3 seconds 1 Raises head at midline and holds it in alignment for 1–2 seconds 0 Head remains extended backward or flexed forward				
7 Start: 4–5 months	2	ALIGNING HEAD *(Held at shoulder)* Hold child at your shoulder with one hand under buttocks and other on child's back. (Head is not supported.) Gently bounce child up and down 3 times.	2 Holds head in midline for 2–3 bounces 1 Holds head in midline for 1 bounce 0 Fails to hold head in midline on each bounce				
8	3	ALIGNING HEAD *(Held in suspended vertical position with head toward ceiling, feet toward floor)* Pick child up (facing you) with your hands around trunk. Slowly tilt child 45 degrees to left of midline. Without pausing, return to midline and tilt 45 degrees to right. Return to midline. Observe alignment of child's head throughout cycle. (Count 4 seconds per segment of movement cycle: left, midline, right, midline.)	2 Holds head in alignment for 75%–100% of movement cycle 1 Holds head in alignment for 50%–74% of movement cycle 0 Holds head in alignment for less than 50% of cycle				
9	3	STABILIZING TRUNK *(Sitting)* Support child in sitting position (side toward you) by holding his or her hips. Child's hands can be placed on surface for additional support.	2 Holds trunk off legs in a 30-degree angle for 5 seconds 1 Holds trunk off legs in less than a 30-degree angle for 5 seconds 0 Trunk remains in contact with legs				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
10 Start: 6 months	4	ALIGNING HEAD *(Sitting, supported with pillows around hips)* Dangle **toy on a string** 12 in. in front of child. Slowly move toy in 180-degree arc, from in front of child to his or her left side, back to front, and then to right side. (Count 4 seconds per segment of movement cycle: left, front, right, front.)	2 Holds head aligned for 8 seconds while rotating head to follow toy 1 Holds head aligned for 4–7 seconds while rotating head to follow toy 0 Holds head aligned for less than 4 seconds				
11	5	SITTING Place child in sitting position, hands on surface beside knees. When balance is secure, release child.	2 Maintains balance for 8 seconds 1 Maintains balance for 3–7 seconds 0 Maintains balance for less than 3 seconds				
12 Start: 7–9 months	6	SITTING/REACHING *(Sitting, pillows supporting hips)* Attract child's attention to **toy on a string** suspended at midline 12 in. in front of child's chest.	2 Maintains balance for 8 seconds while extending arms and hands to grasp toy 1 Maintains balance for 5–7 seconds while extending arms and hands to grasp toy 0 Maintains balance for less than 5 seconds				
13	6	PULLING TO SIT *(Lying on back, feet toward you)* Hold index fingers out, touching child's hands, if necessary, to get child to grasp them. Once fingers are grasped, say, "Get up." Pull your hands back so child's arms become straight.	2 Pulls up to sitting position 1 Pulls up 45–90 degrees from the surface 0 Pulls up less than 45 degrees or remains lying on surface				
14 Start: 10–11 months	6	SITTING Place child in sitting position and release your support.	2 Sits unsupported for 60 seconds 1 Sits unsupported for 30–59 seconds 0 Sits for less than 30 seconds				
15	7	SITTING WITH TOY Place child in sitting position and release your support. Place **toy** 12 in. in front of child. Say, "Get the toy."	2 Retrieves toy, returns to upright sitting, and maintains balance for 30 seconds 1 Retrieves toy, returns to upright sitting, and maintains balance for 15–29 seconds 0 Fails to retrieve toy, return to upright sitting, or maintain balance for 15 seconds				
16 Start: 12–15 months	9	SITTING Place child in sitting position and release your support. Give **toy** to child and say, "Play with the toy."	2 Maintains balance for 60 seconds while manipulating toy 1 Maintains balance for 30–59 seconds while manipulating toy 0 Maintains balance for less than 30 seconds				
17	10	RAISING TO SIT *(Lying on back)* Place child on back on floor. Attract child's attention to **toy** and then place it on chair where child can see it. Say, "Get the toy."	2 Pulls up to sitting position, using chair for support 1 Grasps chair and rotates body in effort to raise up 0 Remains lying on floor				
18	10	SITTING UP *(Lying on stomach)* Place child on stomach on floor. Attract child's attention to **toy**; then hold toy out of child's reach, about 2 ft. above floor. Say, "Get the toy."	2 Raises to sitting position 1 Attempts to maneuver into sitting position 0 Remains lying on floor				
19 Start: 16–26 months	13	KNEELING Place child in a kneeling position, buttocks not resting on heels. Keeping toy at child's eye level and about 2 ft. away, move it in arc to one side of child. Say, "Watch the **toy**." Return toy to starting position and then move it in arc to other side. (Take about 4 seconds for each segment of movement cycle: front to left, left to front, front to right, right to front.)	2 Maintains balance for 5 seconds while rotating head 1 Maintains balance for 2–4 seconds 0 Maintains balance for less than 2 seconds				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
20 Start: 27–48 months	31–32	STANDING ON 1 FOOT Stand on 1 foot, hands on hips with free leg bent back at knee. Say, "Put your hands on your hips and stand on 1 foot like I did."	2 Stands on 1 foot with hands on hips for 3 seconds 1 Stands on 1 foot with hands on hips for 1–2 seconds 0 Requires help to stand on 1 foot				
21	41–42	STANDING ON 1 FOOT Stand on 1 foot, hands on hips with free leg bent back at knee. Say, "Put your hands on your hips and stand on 1 foot like I did."	2 Stands on 1 foot with hands on hips for 5 seconds 1 Stands on 1 foot with hands on hips for 2–4 seconds 0 Stands on 1 foot for less than 2 seconds				
22 Start: 49–56 months	43–44	STANDING ON TIPTOES Stand on tiptoes with hands held overhead for 3 seconds. Say, "Hold your hands over your head and stand on your tiptoes like I did."	2 Stands on tiptoes with arms held overhead and without moving feet for 3 seconds 1 Stands on tiptoes with arms held overhead and without moving feet for 1–2 seconds 0 Moves feet or heels remain on floor				
23	45–46	STANDING ON 1 FOOT Stand on 1 foot, hands on hips with free leg bent back at knee for 5 seconds. Say, "Put your hands on your hips and stand on 1 foot like I did."	2 Stands on 1 foot with hands on hips and without swaying more than 20 degrees for 5 seconds 1 Stands on 1 foot with hands on hips and without swaying more than 20 degrees for 2–4 seconds 0 Stands on 1 foot for less than 2 seconds or sways more than 20 degrees				
24 Start: 57–71 months	51–52	STANDING ON TIPTOES Stand on tiptoes with hands held overhead for 8 seconds. Say, "Hold your hands over your head and stand on your tiptoes like I did for as long as you can."	2 Stands on tiptoes with arms held overhead, without moving feet, and without swaying more than 20 degrees for 8 seconds 1 Stands on tiptoes with arms held overhead, without moving feet, and without swaying more than 20 degrees for 5–7 seconds 0 Stands on tiptoes for less than 5 seconds or sways more than 20 degrees				
25	53–54	STANDING ON 1 FOOT Stand on 1 foot with hands on hips for 10 seconds, then on other foot for 10 seconds. Say, "Put your hands on your hips and stand on each foot like I did." Count seconds out loud to encourage child to balance longer.	2 Stands on 1 foot, then on other foot, with hands on hips and without swaying more than 20 degrees for 6 seconds on each foot 1 Stands on one foot, then on other foot, with hands on hips and without swaying more than 20 degrees for 1–5 seconds on each foot 0 Stands on only 1 foot (does not change feet) or sways more than 20 degrees				
26	57–58	IMITATING MOVEMENTS *(Standing)* Stand 3 feet from child. Say, "I am going to move my arms and I want you to copy my movements." Do practice move (one not on test) to see if child understands. Do not use verbal cues. Present 6 positions one at a time at 1-second intervals.	2 Imitates 4 positions accurately 1 Imitates 1–3 positions accurately 0 Fails to imitate any position accurately				
27	59–60	STANDING ON 1 FOOT Stand on 1 foot with hands on hips for 10 seconds, then on the other foot for 10 seconds. Say, "Put your hands on your hips and stand on 1 foot and then the other like I did." Count seconds out loud to encourage child to balance longer.	2 Stands on each foot with hands on hips and without swaying more than 20 degrees for 10 seconds 1 Stands on each foot with hands on hips and without swaying more than 20 degrees for 5–9 seconds 0 Stands on each foot for less than 5 seconds, sways more than 20 degrees, or stands on only 1 foot				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
28	59–60	SIT-UPS *(Lying down on mat)* Demonstrate sit-ups on mat. Place child in starting position on mat. Hold child's feet and say, "Do as many sit-ups as you can." Stop child after 30 seconds.	2 Completes 3 sit-ups in 30 seconds 1 Completes 1–2 sit-ups in 30 seconds 0 Fails to complete any sit-ups				
29	68–72	SIT-UPS *(Lying down on mat)* Demonstrate sit-ups on mat. Place child in starting position on mat. Hold child's feet and say, "Do as many sit-ups as you can." Stop child after 30 seconds.	2 Completes 5 sit-ups in 30 seconds 1 Completes 3–4 sit-ups in 30 seconds 0 Completes less than 3 sit-ups				
30	72	PUSH-UPS *(Lying face down on mat)* Demonstrate 3 push-ups. Say, "Do as many push-ups as you can." Stop child after 20 seconds.	2 Completes 8 push-ups in 20 seconds 1 Completes 4–7 push-ups in 20 seconds 0 Completes less than 4 push-ups				
		Locomotion					
1 Start: 1–2 months	0	THRUSTING LEGS *(Lying on back)* Stimulate leg thrusts by holding child's feet and pushing them toward his or her body so knees are flexed, legs bent, and heels almost touching buttocks. Then pull child's feet out until legs are fully extended. Repeat motions. Let go of child's feet. Observe for more than 1 minute.	2 Bends and straightens legs (alternately or together) 2 times 1 Bends and straightens legs (alternately or together) 1 time or moves only 1 leg 0 Does not move legs				
2	0	TURNING FROM SIDE TO BACK *(Lying on side, legs bent to maintain balance, examiner in back of child)* Shake **rattle** 3 times behind child's back. Repeat procedure with child lying on opposite side.	2 Rolls onto back (both sides) 1 Rolls onto back (1 side only) 0 Remains on side				
3	0	THRUSTING ARMS *(Lying on back)* Stimulate arms by bringing child's hands together at midchest with elbows bent. Then stretch arms out to sides until elbows are straight and hands touch surface. Repeat. Let go of child's hands. Observe for 1 minute.	2 Bends and straightens arms (alternately or together) 2 times 1 Bends and straightens arms (alternately or together) 1 time or moves only 1 arm 0 Does not move arms				
4	2	BEARING WEIGHT *(Standing)* Hold child in a standing position facing you with his or her feet resting on table or counter top. Observe leg position and whether child can bear weight for 3 seconds.	2 Bears weight with knees flexed and feet flat for 3 seconds 1 Bears weight with knees flexed and toes touching surface for 3 seconds or with knees flexed and feet flat for 1–2 seconds 0 Fails to bear weight or legs remain straight with only toes touching surface				
5 Start: 3–4 months	2	EXTENDING TRUNK *(Lying on stomach, head turned to side, forearms resting on surface)* Attract child's attention by shaking **rattle** 1 in. above surface. Continue to shake rattle and move it 6 in. above child's head.	2 Elevates head and upper trunk 45 degrees, bearing weight on forearms or hands for 3 seconds 1 Elevates head and upper trunk 45 degrees, bearing weight on forearms or hands for 1–2 seconds 0 Elevates head less than 45 degrees				
6	3	SYMMETRICAL POSTURE *(Lying on back; feet toward you)* Shake **rattle** 18 in. from child's nose and then move it to within 12 in.	2 Brings both hands together at midline within 5 seconds (hands come up together) while maintaining midline head and body posture 1 Brings 1 hand to midline and moves the other out of midline while maintaining midline head and body posture 0 Hands remain out of midline position				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
7 Start: 5 months	4	PROPPING ON FOREARMS *(Lying on stomach, chin and forearms resting on surface)* Attract child's attention to **toy on a string** and then suspend it 12 in. above child's face.	2 Elevates head and upper trunk 45 degrees and bears weight on forearms for 5 seconds 1 Elevates head and upper trunk 45 degrees and bears weight on forearms for 3–4 seconds 0 Elevates head and upper trunk, bearing weight for less than 3 seconds, or fails to elevate trunk				
8	4	ROLLING *(Lying on back, feet toward you)* Shake **rattle** at midline 12 in. above child's face. Slowly move rattle in arc toward surface. Repeat procedure to other side.	2 Rolls to side with opposite arm crossing midline (both sides) 1 Rolls to side with opposite arm crossing midline (one side only) 0 Remains on back				
9 Start: 6 months	4	EXTENDING ARMS AND LEGS *(Lying on stomach, head toward you)* Attract child's attention to **toy on a string** that you dangle at midline 12 in. from child's head. Observe child's arms and legs for 5 seconds.	2 Extends arms and legs (alternately or together) off surface for 3 seconds 1 Extends arms and legs (alternately or together) off surface for 1-2 seconds, or moves only arms or legs for 3 seconds 0 Arms and legs remain inactive				
10	5	FLEXING LEGS *(Lying on back, bare feet)* If child has socks on, remove them and then gently bend both legs toward child's face, wiggle and then release them.	2 Brings feet to mouth for play or grabs feet with hands (both feet must come up, alternately or together) 1 Raises feet 90 degrees or less or brings 1 foot to mouth 0 Legs remain on surface				
11	5	EXTENDING ARMS AND LEGS *(Lying on back, head in midline)* Attract child's attention to **toy on a string** that you dangle at midline 12 in. from child's head. Observe child's arms and legs for 5 seconds.	2 Raises arms and legs (alternately or together) in smooth, fluid movements within 5 seconds after toy is presented 1 Raises arms and legs (alternately or together) within 6–7 seconds after toy is presented 0 Arms and legs remain inactive				
12	6	EXTENDING ARM *(Lying on stomach, chin and forearms resting on surface)* Attract child's attention to **toy on a string** just out of reach. Say, "Get the toy."	2 Raises upper trunk, shifts weight to side, lifts free arm, and reaches toward toy 1 Raises upper trunk, shifts weight to side, and lifts free arm without reaching toward toy 0 Both arms remain in contact with surface				
13 Start: 7 months	6	FLEXING BODY *(Lying on back, bare feet)* Gently bend both legs toward head 3 times. Do not place feet in child's hands, but encourage child to grasp them by saying, "Get your feet."	2 Grasps both feet and holds them for 3 seconds 1 Grasps both feet and holds them for 1–2 seconds or grasps 1 foot and holds it for 3 seconds 0 Legs remain on surface				
14	6	PUSHING UP *(Lying on stomach, head turned to side, forearms resting on surface)* Attract child's attention to **rattle.** Shake rattle 12 in. in front of child's forehead and 6 in. above child's head.	2 Elevates head and stomach by pushing up with arms, bearing weight on palms for 5 seconds 1 Elevates head and stomach by pushing up with arms, bearing weight on palms for 3–4 seconds 0 Bears weight for less than 3 seconds				
15	6	EXTENDING ARM *(Lying on back)* Shake **toy on a string** and then hold it 12 in. to right of child's head and 12 in. above surface. Repeat procedure to opposite side.	2 Shifts weight to side and supports self with arm for 3 seconds while extending opposite arm to reach for toy (both sides) 1 Shifts weight to side and supports self with arm for 1–2 seconds while extending opposite arm to reach for toy (1 or both sides) 0 Remains on back				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
16	7	ROLLING *(Lying on back)* Shake **rattle** at midline 12 in. above child. Lower rattle to surface on child's left, out of child's reach. Repeat procedure on opposite side.	2 Rolls from back to stomach (both sides) 1 Rolls from back to stomach (1 side only) 0 Remains on back				
17 Start: 8 months	7	ROLLING *(Lying on back)* Attract child's attention to **toy** by shaking it to side of child. Repeat procedure on opposite side.	2 Rolls from back to stomach, leading with hips and thighs, followed by stomach and then shoulders (both sides) 1 Rolls from back to stomach (1 side only) 0 Remains on back				
18 Start: 9 months	8	MOVING FORWARD *(Lying on stomach)* Place **toy** 5 ft. in front of child. Say, "Get the toy."	2 Moves forward 3 ft. using arms 1 Moves forward at least 2 ft. but less than 3 ft. using arms 0 Moves less than 2 ft.				
19 Start: 10 months	9	RAISING SHOULDERS AND BUTTOCKS *(Lying on stomach)* Sit 3 ft. in front of child. Hold your hands out to child and say, "Come here."	2 Raises and bears weight on hands and knees for 5 seconds and rocks back and forth for 2 cycles 1 Raises and bears weight on hands and knees for 1–5 seconds 0 Remains on stomach				
20	9	CREEPING *(Hands and knees)* Place **toy** on floor 6 ft. in front of child. Say, "Get the toy." Move toy back as child approaches.	2 Creeps forward on hands and knees, using a cross-lateral pattern (opposite arms and legs moving together) for 5 ft. 1 Creeps forward on hands and knees using cross-lateral pattern for 4 ft. or creeps without using cross-lateral pattern for 5 ft. 0 Remains stationary or moves on stomach				
21	9	SCOOTING *(Sitting)* Sit beside child on floor. Say, "Watch me." Demonstrate scooting by using your hands to propel your body forward on your buttocks to retrieve toy. Place **toy** 5 ft. in front of child. Say, "Scoot like I did and get the toy."	2 Maintains sitting posture and uses hands and legs to scoot forward 3 ft. 1 Maintains sitting posture and scoots forward 1–2 ft. 0 Moves less than 1 ft. forward				
22 Start: 11 months	9	PIVOTING *(Sitting)* Place child in sitting position on floor. Attract child's attention to **toy**, then place it 2 ft. from child's right side. Say, "Turn and get the toy." Repeat procedure on opposite side.	2 Turns on buttocks using legs or arms to pivot body 90 degrees (both sides) 1 Turns on buttocks using legs or arms to pivot body 90 degrees (1 side only) 0 Pivots less than 90 degrees				
23	9	STANDING *(Sitting next to stable object, such as chair or table)* Attract child's attention to **toy**, then place it on edge of stable object, out of child's reach. Say, "Get the toy."	2 Raises to standing position using stable object for support 1 Attempts to raise to standing, but returns to sitting 0 Makes no attempt to stand				
24	10	CREEPING *(Sitting on floor to one side of you)* Sit with legs straight and knees touching. Attract child's attention to **toy**, then place toy on the other side of your legs so child will have to climb across your legs to retrieve it. Say, "Get the toy."	2 Creeps completely over your legs 1 Creeps onto your legs 0 Remains stationary or creeps up to your legs				
25	10	BOUNCING *(Standing)* Have child hold your index fingers. Stimulate bouncing by moving your hands up and down 2 times.	2 Bounces 3 times by flexing knees 1 Bounces 1–2 times by flexing knees 0 Stiffens legs or sits down				
26 Start: 12 months	10	CRUISING *(Standing next to low table)* Place child in standing position at end of table. Place **toy** on opposite end of table. Say, "Get the toy."	2 Takes 4 steps sideways (holding on to table) 1 Takes 1–3 steps sideways (holding on to table) 0 Remains stationary				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
27	10	LOWERING Place child in standing position with side next to stable object (chair or low table) for support. Place **toy** on floor in front of child. Say, "Sit down and play with the toy."	2 Lowers to sitting position without falling 1 Lowers self, but falls in process 0 Remains standing				
28	10	STEPPING With child facing you, support child in standing position with your hands around trunk. Say, "Let's walk."	2 Takes 4 alternating steps in place or forward 1 Takes 2–3 alternating steps in place or forward 0 Fails to take alternating steps				
29 Start: 13 months	11	PIVOTING Place child in sitting position straddling one line of **taped 3 × 3 ft. cross.** Attract child's attention to **toy**, then place it on line 2 ft. behind child. Say, "Turn and get the toy."	2 Pivots 180 degrees (straddles line in opposite direction), while remaining seated 1 Pivots 90–179 degrees (body midline fails to straddle line), while remaining seated 0 Pivots less than 90 degrees				
30	11	STANDING Place child in standing position next to stable object (chair or low table). Stand 4 ft. in front of child with your arms outstretched. Say, "Come here."	2 Frees hands and body from support and maintains balance in standing position for 5 seconds 1 Frees hands and body from support and maintains balance in standing position for 2–4 seconds 0 Fails to release support				
31	11	STANDING Place child in standing position away from anything that can be used for support. Release your support of child. (Be ready to catch child if necessary.)	2 Maintains balance for 3 seconds before showing instability or dropping to floor 1 Maintains balance for 1–2 seconds before showing instability or dropping to floor 0 Immediately shows signs of instability or drops to floor				
32	11	STEPPING From in front, support child in standing position by holding 1 hand. Say, "Let's walk."	2 Takes 4 alternating steps in place or forward 1 Takes 2–3 alternating steps in place or forward 0 Fails to take alternating steps				
33 Start: 14 months	12	STANDING UP *(Sitting cross-legged on floor)* Demonstrate standing up from sitting position. Place palms of hands on floor beside hips. Push down with hands, straighten arms, and shift weight to feet. Stand up without turning body more than 20 degrees to either side. Say, "Get up like I did."	2 Stands without turning body more than 20 degrees 1 Stands but turns body 21–90 degrees 0 Turns body more than 90 degrees or fails to stand				
34	12	WALKING *(Standing)* From the side, support child by holding 1 hand. Say, "Let's walk."	2 Uses alternating steps to walk 8 ft. 1 Uses alternating steps to walk 4–7 ft. 0 Walks less than 4 ft.				
35	12	WALKING *(Standing)* Hold **toy** 2 ft. in front of child. Say, "Come get the toy." Move back as needed to keep toy just out of reach.	2 Walks unaided for 5 steps 1 Walks unaided for 1–4 steps 0 Remains stationary or sits down				
36	13	STANDING AND MOVING BALANCE *(Standing)* Place **toy** on floor 2 ft. in front of child. Say, "Get the toy and bring it to me."	2 Picks up toy, returns to standing, and takes 3 steps without losing balance 1 Picks up toy, returns to standing, and takes 1–2 steps before losing balance 0 Remains stationary or loses balance when picking up toy				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
37 Start: 15–16 months	14	CREEPING UP STAIRS *(Sitting on floor, facing stairs)* Place **toy** on 3rd step. Say, "Get the toy." Move toy up as child gets closer. (Be prepared to catch child if necessary.)	2 Creeps up 2 steps on hands and knees 1 Creeps up 1 step on hands and knees 0 Remains on 1st step				
38	14	WALKING Stand 10 ft. in front of child and hold your arms out. Say, "Come to me." **[Record the time it takes to walk 10 ft. for use in Item 41.]** _____ Time to walk 10 ft.	2 Walks 10 ft. with narrow base of support, heel–toe gait, using a reciprocal pattern for at least half the distance 1 Walks 4–9 ft. with narrow base of support, heel–toe gait, using a reciprocal pattern for at least half the distance 0 Walks with wide base of support (feet positioned at shoulder width) and/or arms held out to sides, parallel to surface				
39 Start: 17–18 months	15–16	CREEPING DOWN STAIRS *(On stairs, knees on 4th step, hands on 5th step)* Stand 2 or 3 steps below child. Say, "Come to me." Move backward as necessary.	2 Creeps backward down 3 steps without support (from adult or rail) 1 Creeps backward down 1–2 steps without support (from adult or rail) 0 Remains on 4th step				
40	15–16	WALKING UP STAIRS *(Standing, facing flight of stairs, close to railing or wall)* Place **toy** on 6th step. Get behind child and say, "Walk up the steps and get the toy."	2 Walks up 4 steps with support from wall or rail (may place 1 or both feet on each step) 1 Walks up 1–3 steps with support from wall or rail 0 Remains stationary or drops to hands and knees to ascend steps				
41 Start: 19–20 months	17–18	WALKING FAST Run away from child and say, "Catch me!" _____ Record time to walk 10 ft. _____ Time recorded in Item 38	2 Walks 10 ft. in ½ the time recorded in Item 38 1 Walks 10 ft. in more than ½ but less than ¾ of the time recorded in Item 38 0 Walks 10 ft. in ¾ or more of the time recorded in Item 38				
42	17–18	WALKING BACKWARD Walk backward while pulling **pull toy**. Give cord to child and say, "You pull it like I did."	2 Walks backward 5 steps (may or may not pull toy while walking) 1 Walks backward 2–4 steps 0 Takes less than 2 steps backward				
43 Start: 21–22 months	17–18	WALKING DOWN STAIRS *(Standing on 4th step, next to wall or railing, facing down)* Stand beside child and offer him or her your finger. Say, "Let's walk down the steps."	2 Walks down 4 steps with support only from examiner's finger (may place 1 or both feet on each step) 1 Walks down 1–3 steps with support only from examiner's finger 0 Remains stationary or lowers to sitting to descend steps				
44 Start: 23–24 months	17–18	WALKING BACKWARD Demonstrate walking backward using a normal stride (heels not touching toes). Say, "Walk backward like I did."	2 Walks backward 5 steps 1 Walks backward 2–4 steps 0 Walks backward less than 2 steps				
45	19–20	RUNNING Stand 12 ft. in front of child. Say, "Run to me as fast as you can."	2 Runs forward 10 ft. 1 Runs forward 5–9 ft. 0 Walks or runs less than 5 ft.				
46	19–20	STANDING **Taped line (2 in. × 2 ft.)** Stand on line with 1 foot in front of other, toe of back foot touching heel of front foot. Say, "Stand on the line like I did."	2 Stands on line with 1 foot in front of other for 2 seconds; toe of back foot is within 3 in. of front foot 1 Places 1 foot on line and attempts to place other foot on line 0 Makes no attempt to place 2nd foot on line				

Item #	Age In Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
47 Start: 25–26 months	21–22	WALKING SIDEWAYS Face child and say, "Watch me." Step sideways, leading with same foot, for 10 ft. Say, "Walk like I did."	2 Walks sideways for 10 ft., leading with same foot 1 Walks sideways 4–9 ft., leading with same foot for half the steps 0 Remains stationary or walks in a manner other than sideways				
48	21–22	WALKING LINE **Taped line (4 in. × 8 ft.)** Walk on the line with 1 foot on line and other foot beside it. Say, "Walk on the line like I did."	2 Walks with 1 foot on line for 6 ft. 1 Walks with 1 foot on line for 4–5 ft. 0 Walks for less than 4 ft. on line				
49	23–24	JUMPING FORWARD **Taped line on floor (2 in. × 2 ft.)** Using 2-footed takeoff and landing, jump forward 12 in. from starting line. Say, "Jump like I did." Measure distance from line to point where nearest heel touches floor.	2 Jumps forward 4 in., maintaining balance 1 Jumps less than 4 in. forward, maintaining balance 0 Steps forward or falls				
50	23–24	JUMPING UP Demonstrate jumping up with your feet together, knees flexed, and body propelled upward. Say, "Jump like I did."	2 Jumps up 2 in. with feet together 1 Jumps up with feet barely leaving floor, or jumps up 2 in. with 1 foot leading the other 0 Keeps toes in contact with floor				
51 Start: 27–30 months	23–24	JUMPING DOWN *(Standing on step 7 in. high)* Stand in front of child and say, "Jump down."	2 Jumps down without assistance; 1 foot may lead 1 Steps down without assistance 0 Needs assistance to get down				
52	23–24	WALKING UP STAIRS *(Standing, facing flight of stairs, at middle of step width)* Place **toy** on 6th step. Say, "Walk up the steps without holding on."	2 Walks up 4 steps without support from wall or rail (may place 1 or both feet on each step) 1 Walks up 4 steps using rail or wall for support 0 Remains stationary or drops to hands and knees to ascend stairs				
53	25–26	WALKING DOWN STAIRS *(Standing on 4th step, facing down stairs, next to wall or railing)* Stand 2 steps below child. Say, "Walk down to me." Move down as child begins to descend.	2 Walks down 4 steps without support by placing 1 or both feet on each step 1 Walks down 1–3 steps without support 0 Remains stationary or uses wall or rail for additional support				
54	25–26	WALKING BACKWARD Demonstrate walking backward 10 ft. using a normal backward stride (without touching heels to toes). Say, "Walk backward like I did."	2 Walks backward 10 ft. without heels touching toes 1 Walks backward 1–9 ft. 0 Walks backward less than 1 ft.				
55	25–26	JUMPING UP *(Standing next to wall)* **Mark on wall at standing reach and line 2 in. higher** Demonstrate jumping up and touching wall as high as you can. Point to line and say, "Jump up and touch as high as you can."	2 Jumps up and touches line or above 1 Jumps up and touches between mark and line 0 Keeps toes in contact with floor or fingers touch below mark				
56	27–28	WALKING LINE **Taped line (4 in. × 8 ft.)** Using a normal stride (heels not touching toes), walk forward 3 steps on line. Say, "Keep your hands on your hips and walk on the line like I did."	2 Takes 3 steps forward on line with hands on hips and without heels touching toes 1 Takes 1–2 steps forward on line with hands on hips and without heels touching toes 0 Walks with one foot off the line				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
57 **Start: 31–34 months**	27–28	WALKING UP STAIRS *(Standing at foot of stairs)* Get behind child and say, "Walk up the steps."	2 Walks up 4 steps, placing 1 foot on each step, using wall or rail for support 1 Walks up 1–3 steps, placing 1 foot on each step, using wall or rail for support 0 Remains stationary or places both feet on each step and uses support				
58	29–30	JUMPING DOWN *(Standing on stable object 16–21 in. high)* Say, "Jump down."	2 Jumps down without assistance, 1 foot may lead 1 Steps down without assistance 0 Needs assistance to get down				
59	29–30	WALKING ON TIPTOES Walk on tiptoes with your hands on hips for 5 steps. Say, "Keep your hands on your hips and walk on your tiptoes like I did."	2 Walks on tiptoes for 5 steps with hands on hips and without heels touching floor 1 Walks on tiptoes for 1–4 steps with hands on hips and without heels touching floor 0 Walks with heels touching floor				
60 **Start: 35–38 months**	29–30	RUNNING SPEED With **taped lines (2 in. × 2 ft.) 30 ft. apart**, place child with toes behind starting line. Stand 1 yd. behind finish line and say, "Run to me as fast as you can." Time from when child starts running to when he or she crosses finish line.	2 Runs 30 ft. in 6 seconds or less 1 Runs 30 ft. in 7–9 seconds 0 Walks or runs 30 ft. in more than 9 seconds				
61	31–32	JUMPING FORWARD *(Standing with toes on line)* **Taped line (2 in. × 2 ft.)** Demonstrate jumping forward using 2-footed takeoff and landing. Say, "Jump like I did."	2 Jumps forward 24 in. using 2-footed takeoff and landing 1 Jumps forward 12–23 in. using 2-footed takeoff and landing 0 Jumps forward less than 12 in., steps forward, or falls				
62	31–32	JUMPING DOWN *(Standing on stable object 18–24 in. high)* Say, "Jump down with both feet together."	2 Jumps down without assistance using 2-footed takeoff and landing 1 Jumps down, taking off with 1 foot and landing on both feet without assistance, or takes off with 2 feet and falls on landing 0 Needs assistance to get down				
63	33–34	JUMPING HURDLES **String (or rope) tied between 2 chair legs, 2 in. off floor and 3 ft. apart** (Tie loosely to prevent tripping.) Stand 6 in. away from and facing string. Using 2-footed takeoff and landing, jump over string. Say, "Jump over the string like I did."	2 Jumps over string without tripping using 2-footed takeoff and landing 1 Jumps over string without tripping using 1-footed takeoff and landing 0 Steps over, or jumps but remains on same side				
64 **Start: 39–42 months**	33–34	WALKING ON TIPTOES **Taped line (4 in. × 8 ft.)** Walk on tiptoes, hands on hips, for entire length of line. Say, "Keep your hands on your hips and walk on your tiptoes like I did."	2 Walks on tiptoes for entire length of line with hands on hips and without heels touching floor 1 Walks on tiptoes for 1–7 ft. with hands on hips and without heels touching floor 0 Walks on tiptoes for less than 1 ft. on line				
65 **Start: 43–45 months**	35–36	WALKING UP STAIRS *(Standing centered at foot of stairs)* Place a **toy** on the 6th step. Stand behind child and say, "Walk up the steps and get the toy."	2 Walks up 4 steps without support, placing 1 foot on each step 1 Walks up 1–3 steps with support from wall or rail and placing 1 foot on each step, or walks up 4 steps without support but placing both feet on each step 0 Remains stationary or places both feet on each step and uses support				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
66	37–38	RUNNING SPEED **Taped lines (2 in. × 2 ft.) 45 ft. apart** Place the child within 6 in. behind a taped line on the floor and then stand 3 ft. behind finish line. Say, "Run to me as fast as you can without stopping."	2 Runs 45 ft. in 6 seconds or less 1 Runs 45 ft. in 7–9 seconds 0 Walks or runs 45 ft. in more than 9 seconds				
67	39–40	JUMPING FORWARD **Taped line (2 in. × 2 ft.)** Demonstrate jumping forward using a 2-footed takeoff and landing. Say, "Jump like I did."	2 Jumps forward 26 in. using 2-footed takeoff and landing 1 Jumps forward 12–25 in. using 2-footed takeoff and landing 0 Jumps forward less than 12 in. or falls				
68 Start: 46–50 months	41–42	WALKING LINE **Taped line (4 in. × 8 ft.)** Using a normal stride (heels not touching toes), walk forward on line. Say, "Keep your hands on your hips and walk on the line like I did. Try not to step off the line."	2 Walks forward 4 ft. without stepping off line, with hands on hips and without heels touching toes 1 Walks forward 4 ft. on line, stepping off 1 time, with hands on hips and without heels touching toes 0 Steps off line more than once				
69	41–42	RUNNING FORM Say, "When I say go, run fast and keep running until I say stop." Stop child after 10 seconds.	2 Runs with arms moving back and forth across body and at or below waist, balls of feet used to push forward, toes pointed forward, a high knee and heel lift, and trunk leaning forward 1 Runs with arms held out to side, or feet remain flat during the run 0 Walks at any time during 10-second period				
70	41–42	WALKING LINE FORWARD **Taped line (4 in. × 8 ft.)** Using a normal stride (heels not touching toes) and with hands on hips, walk forward on line. Say, "Keep your hands on your hips and walk on the line like I did. Try not to step off the line."	2 Walks forward 8 ft. on line without stepping off, with hands on hips, without heels touching toes, and without swaying more than 20 degrees 1 Walks forward 8 ft. on line and steps off 1 time, with hands on hips, without heels touching toes, and without swaying more than 20 degrees 0 Steps off line more than once or sways more than 20 degrees				
71	43–44	WALKING DOWN STAIRS *(Standing on 4th step, facing down stairs)* Stand 2 or more steps below child and say, "Walk down the steps without holding on." Move down as child descends.	2 Walks down 4 steps, placing 1 foot on each step without support 1 Walks down 4 steps, placing both feet on 1 or 2 steps without support 0 Remains stationary or places both feet on each step for 3 or more steps				
72 Start: 51–54 months	43–44	JUMPING FORWARD ON 1 FOOT **Taped line (2 in. × 2 ft.)** Jump forward on 1 foot without letting other foot touch floor. Say, "Jump forward like I did." Measure from line to point where back of heel touches floor.	2 Jumps forward 6 in. on 1 foot without other foot touching floor 1 Jumps forward 2–5 in. on 1 foot without other foot touching floor 0 Jumps less than 2 in. or 2nd foot touches floor				
73	45–46	JUMPING UP *(Standing next to wall)* **Mark on wall at standing reach and line (2 in. × 1 ft.) 3 in. higher** Demonstrate jumping up and touching wall as high as you can. Point to line and say, "Jump and touch as high as you can."	2 Jumps up and touches line or above 1 Jumps up and touches between mark and line 0 Toes remain in contact with floor or fingers touch mark or below				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
74	45–46	RUNNING BALANCE/COORDINATION Demonstrate running and stopping on command. Say, "When I say go, run until I say stop. Then stop as quickly as you can. Stay still until I say go. Then run until I say stop." Stop child after 3 cycles.	2 Runs and stops within 2 steps without falling 1 Runs and stops in 3 or more steps without falling 0 Fails to run or takes more than 3 steps to stop				
75 Start: 55–58 months	45–46	WALKING LINE BACKWARD **Taped line (4 in. × 8 ft.)** Using normal stride (heels not touching toes) and with hands on hips, walk backward on line. Say, "Put your hands on your hips and walk backward like I did."	2 Walks backward 4 ft. without stepping off line more than once, with hands on hips, and without heels touching toes 1 Walks backward 4 ft. on line and steps off 2–5 times with hands on hips and without heels touching toes 0 Steps off line more than 5 times				
76	47–48	JUMPING FORWARD **Taped line (2 in. × 2 ft.)** Demonstrate jumping forward using a 2-footed takeoff and landing. Say, "Jump like I did." Measure from line to point where back of nearest heel touches floor.	2 Jumps forward 30 in. using 2-footed takeoff and landing 1 Jumps forward 20–29 in. using 2-footed takeoff and landing 0 Jumps forward less than 20 in. or falls				
77	47–48	HOPPING Hop forward on 1 foot for 5 hops, then on other foot for 5 hops. Say, "Hop like I did."	2 Hops forward 5 hops on 1 foot, then 3–5 hops on other foot 1 Hops forward 1–4 hops on 1 foot, 1–2 hops on other foot 0 Hops in place, or foot fails to leave ground				
78	51–52	WALKING LINE BACKWARD **Taped line (4 in. × 8 ft.)** With toes touching heels and hands on hips, walk backward on line. Say, "Put your hands on your hips and walk backward touching your heels with your toes like I did. Try not to step off the line."	2 Walks backward 5 steps without stepping off line and with hands on hips and toes touching heels 1 Walks backward 2–4 steps without stepping off line and with hands on hips and toes touching heels 0 Takes less than 2 steps backward				
79	51–52	ROLLING FORWARD *(Crouching on edge of mat)* Demonstrate forward roll. Place child on edge of mat in crouching position. Say, "Turn a forward roll like I did."	2 Completes forward roll without turning more than 15 degrees to either side 1 Completes forward roll but turns more than 15 degrees to either side 0 Fails to complete forward roll				
80 Start: 59–62 months	51–52	GALLOPING Gallop 8–10 ft. (same foot leading). Say, "Gallop like I did."	2 Gallops 10 ft. with weight transferred smoothly and evenly; arms move freely in opposition to legs 1 Gallops 5–9 ft. with weight transferred smoothly and evenly; arms move freely in opposition to legs 0 Gallops less than 5 ft.				
81	53–54	JUMPING FORWARD **Taped line (2 in. × 2 ft.)** From taped starting line, demonstrate jumping forward using 2-footed takeoff and landing. Say, "Jump like I did as far as you can."	2 Jumps forward 36 in. using 2-footed takeoff and landing 1 Jumps forward 20–35 in. using 2-footed takeoff and landing 0 Jumps forward less than 20 in. or falls				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
82	53–54	TURNING JUMP *(Standing with hands on hips, feet 2–4 in. on either side of line)* **Taped line (2 in. × 2 ft.)** With body not deviating more than 20 degrees from vertical, jump and turn 180 degrees. Land with feet opposite original position. Say, "Jump and turn in the air like I did."	2 Jumps and turns so feet land in opposite direction from starting position with hands on hips and body not deviating more than 20 degrees from vertical 1 Jumps and turns at least 90 degrees but less than 180 degrees with hands on hips and body not deviating more than 20 degrees from vertical 0 Turns less than 90 degrees				
83 Start: 63–71 months	53–54	HOPPING FORWARD **2 taped lines (2 in. × 2 ft.), 3 ft. apart** Hop on 1 foot from one line to other, change feet, and hop back to first line. Say, "Hop like I did." If necessary, remind child to change feet when hopping back.	2 Hops on 1 foot from one line to other, changes feet, and hops back to 1st line 1 Hops on 1 foot from one line to other, changes feet, and hops 1–2 hops toward 1st line 0 Hops in place or fails to hop to line				
84	57–58	JUMPING HURDLES **String (or rope) tied between 2 chair legs, 3 ft. apart, 10 in. off floor** (Tie loosely to prevent tripping.) Stand 6 in. away from and facing string. Using 2-footed takeoff and landing, jump over string. Say, "Jump over the string like I did."	2 Jumps over string without tripping using 2-footed takeoff and landing 1 Jumps over string without tripping using 1-footed takeoff and landing 0 Steps over string or jumps but remains on same side				
85	57–58	RUNNING SPEED AND AGILITY **2 taped lines (2 in. × 2 ft.), 10 ft. apart; empty soft drink can** Place can on one line. Have child stand just behind other line. Say, "When I say go, run as fast as you can, pick up the can, and bring it back across the starting line." (Allow 30 seconds of rest between trials.)	2 Completes cycle in 5 seconds or less without tripping or dropping can 1 Completes cycle in 6–10 seconds without tripping or dropping can 0 Takes more than 10 seconds to return to starting line				
86	57–58	SKIPPING Demonstrate skipping for 10 steps. Say, "Skip like I did."	2 Skips 8 steps maintaining balance, using opposing arm and leg movements, and using alternating feet 1 Skips 4–7 steps maintaining balance, using opposing arm and leg movements, and using alternating feet 0 Skips less than 4 steps or holds arms stiffly at sides				
87	59–60	JUMPING SIDEWAYS *(Standing, hands on hips, side to line)* **Taped line (2 in. × 2 ft.)** With feet together and without pausing, jump back and forth (sideways) over line for 3 left–right cycles. Say, "Jump across the line like I did."	2 Jumps back and forth 3 cycles with hands on hips, feet together, and without touching line or pausing between jumps 1 Jumps back and forth 1–2 cycles with hands on hips, feet together, and without touching line or pausing between jumps 0 Lands on line or pauses between jumps				
88	61–62	SKIPPING Demonstrate skipping 10 ft. Say, "Skip like I did."	2 Skips 10 ft. maintaining balance and rhythm, using opposing arm and leg movements, and using alternating feet 1 Skips 5–9 ft. maintaining balance and rhythm, using opposing arm and leg movements, and using alternating feet 0 Skips less than 4 ft. or holds arms stiffly at sides				
89	63–64	HOPPING SPEED **2 taped lines (2 in. × 2 ft.), 20 ft. apart** Place child behind starting line. Say, "Hop on 1 foot to the other line as fast as you can."	2 Hops 20 ft. in 6 seconds or less without losing balance or letting free foot touch floor 1 Hops 20 ft. in 7–10 seconds without losing balance or letting free foot touch floor 0 Hops less than 20 ft. or requires more than 10 seconds				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
Object Manipulation							
1 **Start: 12–16 months**	12	CATCHING BALL *(Sitting, legs spread apart facing you, you and child sitting 3 ft. apart)* Roll **ball** from between your legs to child. Say, "Catch the ball."	2 Corrals ball with arms and/or hands without losing balance 1 Corrals ball, but loses balance 0 Misses ball				
2	13	ROLLING BALL *(Sitting, legs spread apart facing you, you and child sitting 3 ft. apart)* Roll **ball** from between your legs to child. Place ball on floor between child's knees. Say, "Roll the ball to me."	2 Rolls ball 3 ft. forward using hand/arm contact 1 Rolls ball 2–3 ft. forward using hand/arm contact 0 Rolls ball forward 2 ft. or less				
3	13	FLINGING BALL *(Standing in an open area)* Give **tennis ball** to child and stand 5 ft. away. Extend your hands to child and say, "Throw the ball to me."	2 Throws ball in any direction by extending arm at shoulder or elbow 1 Releases ball without extending arm at elbow 0 Holds ball or lays it down				
4 **Start: 17–20 months**	15–16	KICKING BALL *(Standing in an open area)* Kick a stationary **ball** so that it travels 3 ft. forward. Place ball 6 in. in front of child and say, "Kick the ball like I did."	2 Lifts foot and contacts ball 1 Lifts foot and attempts to kick ball 0 Fails to lift foot				
5	15–16	THROWING BALL *(Standing in an open area)* Give **tennis ball** to child and stand 5 ft. away. Say, "Throw the ball to me."	2 Throws ball by extending arm at shoulder or elbow while maintaining balance 1 Throws ball using an extended arm, but loses balance 0 Drops ball				
6 **Start: 21–28 months**	19–20	KICKING BALL *(Standing in an open area)* Kick a stationary **ball** so it travels 3 ft. forward. Place ball 6 in. in front of child and say, "Kick the ball like I did."	2 Kicks ball forward 3 ft. without it deviating more than 45 degrees to either side of midline 1 Kicks ball forward 3 ft. but it deviates more than 45 degrees from midline 0 Ball travels less than 3 ft.				
7	19–20	THROWING BALL—Overhand *(Standing in an open area)* Demonstrate throwing **tennis ball** overhand at least 3 ft. forward. Give ball to child. Say, "Throw the ball as far as you can."	2 Throws ball forward 3 ft. in the air 1 Throws ball forward 1–2 ft. in the air 0 Drops ball or throws in direction other than forward				
8	23–24	THROWING BALL—Underhand *(Standing in an open area)* Demonstrate throwing **tennis ball** underhand at least 5 ft. Give ball to child. Say, "Throw the ball as far as you can."	2 Throws ball forward 3 ft. in the air 1 Throws ball forward 1–2 ft. in the air 0 Drops ball or throws in any direction other than forward				
9 **Start: 29–38 months**	23–24	KICKING BALL *(Standing in an open area)* Kick stationary **ball** so it travels 3 ft. forward. Place ball 6 in. in front of child and say, "Kick the ball like I did."	2 Kicks ball forward 3 ft. without it deviating more than 20 degrees to either side of midline 1 Kicks ball forward 3 ft. but it deviates more than 20 degrees from midline 0 Ball travels less than 3 ft. and deviates more than 20 degrees from midline				
10	25–26	CATCHING BALL *(Standing in an open area)* Stand 5 ft. in front of child. Say, "Catch the ball." Toss **ball** so that it arrives at chest height, contacting child's outstretched arms.	2 Presents extended arms directly in front, palms upward or facing each other; attempts to secure ball by bending arms toward chest (may or may not catch ball) 1 Presents extended arms directly in front, palms upward or facing each other; arms remain straight when contacted by ball 0 Turns away from thrown ball				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
11	27–28	THROWING BALL—Overhand *(Standing in an open area)* Demonstrate throwing **tennis ball** overhand at least 7 ft. Give ball to child. Stand 8 ft. away and say, "Throw me the ball."	2 Initiates throw by moving arm upward and back; ball travels 7 ft. in the air 1 Initiates throw by moving arm down and back, sideways and back, upward, or downward; ball travels 6 ft. or less in the air 0 Drops ball or throws in any direction other than forward				
12 Start: 39–46 months	29–30	THROWING BALL—Underhand *(Standing in an open area)* Demonstrate throwing the **tennis ball** underhand at least 7 ft. forward. Give ball to child. Stand 8 ft. away and say, "Throw me the ball."	2 Initiates throw by moving arm down and back; ball travels forward 7 ft. in the air 1 Initiates throw by moving arm sideways, upward, or forward; ball travels less than 7 ft. in the air 0 Drops ball or throws in any direction other than forward				
13	29–30	KICKING BALL *(Standing in an open area)* Kick stationary **ball** so that it travels at least 6 ft. forward. Place ball 6 in. in front of child and say, "Kick the ball hard like I did."	2 Kicks ball forward 6 ft. using opposing arm and leg movements and initiating kick by extending leg back with bent knee 1 Kicks ball forward 2–6 ft. using opposing arm and leg movements and initiating kick by extending leg back with bent knee 0 Fails to use opposing arm and leg movements or ball travels less than 2 ft.				
14	33–34	CATCHING BALL *(Standing in an open area)* Stand 5 ft. in front of child. Say, "Catch the ball." Toss **ball** so that it arrives at chest height, contacting child's outstretched arms.	2 Catches ball with hands and arms extended 1 Brings arms toward chest in effort to catch after ball contacts hands and arms 0 Turns away from ball or arms remain stationary				
15 Start: 47–52 months	39–40	THROWING BALL—Overhand *(Standing in an open area)* Demonstrate throwing **tennis ball** overhand at least 10 ft. Give ball to child. Stand 11 ft. away and say, "Throw the ball as far as you can."	2 Throws ball forward 10 ft. by moving arm up and back using upper trunk rotation, arms and legs moving in opposition 1 Throws ball forward 3–9 ft. by moving arm up and back or sideways and back using upper trunk rotation, arms and legs moving in opposition 0 Throws ball forward less than 3 ft. or throws ball by moving arm down and back with trunk remaining stationary				
16	39–40	HITTING TARGET—Underhand *(Standing 5 ft. from wall)* From 5 ft. away, toss **tennis ball** underhand to **2-ft. target taped on wall (2 ft. above floor)**. Say, "Throw the ball and hit the target like I did."	2 Hits target 2 of 3 trials using an underhand toss 1 Hits target 1 of 3 trials using an underhand toss 0 Fails to hit target using underhand toss				
17	41–42	CATCHING BALL *(Standing in an open area)* Stand 5 ft. in front of child. Say, "Catch the ball." Toss **ball** so that it arrives at chest height.	2 Catches ball with hands (securing it to chest if necessary) with arms bent 45–90 degrees at the elbows and palms up or facing each other 1 Catches ball by encircling it with arms and hands, then pulling ball to chest (arms may be held out straight in preparation to catch) 0 Fails to catch ball				
18	43–44	HITTING TARGET—Overhand *(Standing 5 ft. from wall)* From 5 ft. away, toss **tennis ball** twice overhand to **2-ft. target taped on wall (2 ft. above floor)**. Say, "Throw the ball and hit the target like I did."	2 Hits target 2 of 3 trials using an overhand toss 1 Hits target 1 of 3 trials using an overhand toss 0 Fails to hit target using overhand toss				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
19 Start: 53–64 months	45–46	THROWING BALL—Underhand *(Standing in an open area)* Demonstrate throwing **tennis ball** underhand at least 10 ft. Give ball to child. Stand about 12 ft. away and say, "Throw the ball as far as you can."	2 Throws ball 10 ft. using upper trunk rotation, arms and legs moving in opposition, and initiating the throw by moving arm down and back 1 Throws ball 3–9 ft. using upper trunk rotation, arms and legs moving in opposition, and initiating the throw by moving arm down and back or sideways and back 0 Throws by moving arm up and back (trunk remains stationary) or ball travels less than 3 ft.				
20 Start: 65–71 months	51–52	HITTING TARGET—Overhand *(Standing 12 ft. from wall)* From 12 ft. away, toss **tennis ball** overhand to **2-ft. target taped on wall (2 ft. above floor)**. Say, "Throw the ball and hit the target like I did."	2 Hits target 2 of 3 trials using an overhand toss 1 Hits target 1 of 3 trials using an overhand toss 0 Fails to use overhand toss or to hit target				
21	51–52	BOUNCING BALL *(Standing 5 ft. from wall)* Using 1 hand, bounce **tennis ball** so it bounces once and then hits wall. Give ball to child and say, "Bounce the ball like I did."	2 Bounces ball to wall so it hits floor once and then hits wall 1 Bounces ball to wall so it hits floor more than once before hitting wall 0 Throws ball that hits wall first or misses wall after bounce				
22	51–52	CATCHING BALL *(Standing in an open area)* Stand 5 ft. in front of child. Say, "Catch the ball." Toss **tennis ball** in a 45-degree arc so it arrives at child's hands.	2 Catches ball on 2 of 3 trials with arms bent and using only hands 1 Catches ball on 1 of 3 trials with arms bent and using only hands 0 Fails to catch ball				
23	68–72	KICKING BALL *(Standing in an open area)* Kick a stationary **ball** so that it travels in the air for at least 12 ft. Place ball 6 in. in front of child's feet and say, "Kick the ball like I did."	2 Kicks ball so it travels 12 ft. in the air using opposing arm and leg movements and initiating kick by extending leg back with bent knee 1 Kicks ball so it travels 6–11 ft. in the air using opposing arm and leg movements and initiating kick by extending leg back with bent knee 0 Kicks ball that travels less than 6 ft. in air or fails to use opposing arm and leg movements				
24	68–72	CATCHING BOUNCED BALL Bounce **tennis ball** on floor once and catch it with 1 hand. Say, "Bounce and catch the ball like I did."	2 Bounces and catches ball on 2 of 3 trials 1 Bounces and catches ball on 1 of 3 trials 0 Fails to catch ball				
Fine Motor Scales							
Grasping							
1 Start: 1–2 months	0	GRASPING REFLEX *(Lying on back)* Stimulate child's palm by inserting your index finger into thumb side of palm.	2 Closes fingers in tight grasp around examiner's finger 1 Bends fingers loosely around examiner's finger 0 Extends fingers, fails to bend them				
2	0	GRASPING CLOTH *(Lying on back)* Spread **washcloth** over your forearm. Place child's hand on top of washcloth.	2 Grasps cloth in hand 1 Scratches at cloth but fails to grasp it 0 Extends fingers, fails to grasp cloth				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
3	0	RELEASING RATTLE—Disappearing Reflex *(Lying on back)* Place **rattle** in child's hand. After child holds rattle for 5 seconds, observe amount of time before release.	2 Drops rattle within 3 additional seconds 1 Drops rattle within 4–5 additional seconds 0 Drops rattle after 5 additional seconds				
4	2	GRASPING RATTLE *(Lying on back)* Lightly touch child's palm with **rattle**. Say, "Get your rattle."	2 Grasps rattle 1 Touches rattle with fingers but fails to grasp it 0 Fails to extend fingers				
5 Start: 3–5 months	2	HOLDING RATTLE *(Lying on back)* Place **rattle** in child's hand.	2 Holds rattle for 30 seconds 1 Holds rattle for 15–29 seconds 0 Holds rattle for less than 15 seconds				
6	3	MANIPULATING RATTLE *(Lying on back)* Shake **rattle** and place it in child's hand. Say, "Shake your rattle."	2 Moves rattle 15 degrees 1 Moves rattle 5–14 degrees 0 Moves rattle 4 degrees or less				
7	4	GRASPING RATTLE *(Sitting on lap, facing table)* Place **rattle** on table within 3 in. of child's hand. Say, "Get your rattle."	2 Grasps rattle 1 Touches rattle 0 Extends arm toward rattle				
8 Start: 6 months	5	PULLING STRING *(Lying on stomach)* Place **toy on a string** so string is at midline between child's hands. Say, "Get the toy."	2 Grasps string, pulls it, and obtains toy 1 Grasps, touches, or pulls string 0 Looks at toy				
9	5	SECURING PAPER *(Sitting on lap, facing table)* Place **8.5 × 11 in.** paper within 3 in. of child's hand. Say, "Get the paper."	2 Secures paper by pulling with open hand or by wrinkling it 1 Touches paper 0 Extends hand toward paper				
10	5	GRASPING CUBE *(Sitting on lap, facing table)* Place **cube** on table within 3 in. of child's hand. Say, "Get the block."	2 Grasps cube for 15 seconds 1 Touches cube for 15 seconds 0 Extends hand to cube but fails to touch				
11 Start: 7–9 months	6	GRASPING CUBE *(Sitting on lap, facing table)* Place **cube** on table within 3 in. of child's hand. Say, "Get the block." Observe how child picks up cube.	2 Grasps cube with 4th and 5th fingers and palm, or grasps cube with thumb and 1st and 2nd fingers 1 Grasps cube with little finger and palm 0 Grasps cube with whole fist				
12	6	SHAKING RATTLE *(Sitting on lap, facing table)* Place **rattle** in child's hand. Say, "Shake your rattle."	2 Holds and moves rattle for 60 seconds 1 Holds and moves rattle for 11–59 seconds 0 Moves rattle for 10 seconds or less				
13	7	SHAKING RATTLE *(Sitting on lap, facing table)* Shake **rattle** back and forth through a 90-degree arc 3 times. Place it on table in front of child. Say, "Shake the rattle."	2 Moves rattle 3 times through 90-degree arcs 1 Moves rattle 3 times through 45- to 89-degree arcs 0 Moves rattle less than 45 degrees or arcs less than 3 times				
14	7	GRASPING CUBE *(Sitting on lap, facing table)* Place **cube** on table within 3 in. of child's hand. Say, "Get the block." Observe how child picks up cube.	2 Grasps cube with thumb and 1st and 2nd fingers with space visible between cube and palm 1 Grasps cube with 1st and 2nd fingers and heel of palm (no space between cube and palm) 0 Grasps cube with whole fist				
15 Start: 10–12 months	8	GRASPING PELLETS *(Sitting on lap, facing table)* Place **2 food pellets** on table within child's reach. Say, "Get all the food."	2 Grasps both pellets at once using a raking motion with fingers 1 Grasps 1 pellet using a raking motion with fingers 0 Touches pellet(s)				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
16	8	MANIPULATING PAPER *(Sitting on lap, facing table)* Cut **8.5 × 11 in. sheet of paper** in half. Place half on table. Say, "Watch me crumple the paper." Crumple paper in 1 hand. Place other half of paper within 3 in. of child's hand. Say, "Crumple the paper like I did."	2 Crumples paper with palm(s) (1 or 2 hands) 1 Wrinkles paper with fingers 0 Touches or pulls paper				
17	8	GRASPING PELLETS *(Sitting on lap, facing table)* Place **2 food pellets** on table within child's reach. Say, "Get all the food."	2 Grasps 2 pellets using raking motion, but with thumb against side of curled index finger, or grasps 1 pellet with thumb and pad of index finger 1 Grasps 1 pellet with thumb and index finger 0 Grasps both pellets at once using a raking motion				
18 Start: 13–20 months	11	GRASPING PELLETS *(Sitting on lap, facing table)* Place **2 food pellets** on table within child's reach. Say, "Get all the food."	2 Grasps 1 or 2 pellets with pad of thumb and pad of index finger; hand, wrist, and arm off table 1 Grasps 1 or 2 pellets with pad of thumb and pad of index finger; arm on table 0 Grasps pellet using grasp other than thumb and pad of index finger				
19	11	GRASPING CUBE *(Sitting on lap, facing table)* Place **cube** on table within 3 in. of child's hand. Say, "Get the block." Observe how child picks up cube.	2 Grasps cube with thumb opposed to 1st and 2nd finger pads with space visible between cube and palm and with hand approaching from top 1 Grasps cube with thumb and 1st and 2nd finger pads with hand approaching from side (but not in contact with table) 0 Grasps cube with whole fist				
20 Start: 21–34 months	13	GRASPING CUBES *(Sitting on lap, facing table)* Place **2 cubes** side by side. Pick up both cubes with 1 hand. Place cubes on table and say, "Pick up both blocks with 1 hand like I did."	2 Grasps both cubes with 1 hand and holds them for 3 seconds 1 Grasps both cubes with 1 hand and holds them for less than 3 seconds 0 Grasps 1 cube				
21 Start: 35–71 months	15–16	GRASPING MARKER *(Sitting at table)* Place **paper and marker** by child's hand on table. Say, "Make a mark." Observe how child holds marker.	2 Grasps marker with thumb and 1st finger toward paper and remaining fingers around marker 1 Grasps marker with thumb up and little finger toward paper 0 Fails to grasp marker				
22	41–42	GRASPING MARKER *(Sitting at table)* Place **paper and marker** by child's hand on table. Say, "Make a mark." Observe how child holds marker.	2 Grasps marker with thumb and pad of index finger; other 3 fingers are secure against palm; upper portion of marker rests between thumb and index finger; child moves hand as unit when drawing 1 Grasps marker with thumb and pad of index finger; upper portion of marker rests between thumb and index finger 0 Grasps marker with thumb and 1st finger				
23	41–42	UNBUTTONING BUTTONS *(Sitting at table)* Place **button strip** on table. Say, "Unbutton these as fast as you can."	2 Unbuttons 3 buttons in 75 seconds or less 1 Unbuttons 3 buttons in 76 seconds or more 0 Attempts to unbutton buttons				
24	47–48	BUTTONING BUTTON *(Sitting at table)* Place **button strip** on table. Unbutton the buttons. Point to an end button and say, "Button and unbutton this one as fast as you can."	2 Buttons and unbuttons 1 button in 20 seconds or less 1 Buttons and unbuttons 1 button in 21 seconds or more 0 Holds both strips together				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
25	49–50	GRASPING MARKER *(Sitting at table)* Place **paper and marker** by child's hand on table. Say, "Make a mark." Observe how child holds marker.	2 Grasps marker between thumb and pad of index finger; marker rests on first joint of middle finger 1 Grasps marker between thumb and pad of index finger; marker rests on first knuckle or pad of middle finger 0 Grasps marker with thumb and 1st finger				
26	53–54	TOUCHING FINGERS At the rate of 1 touch per second, beginning with index finger, touch each finger in succession to thumb. Say, "Touch like I did as fast as you can."	2 Touches each finger to thumb within 8 seconds 1 Touches each finger to thumb in 9–12 seconds 0 Touches each finger in 13 seconds or more				
		Visual-Motor Integration					
1 Start: 1–2 months	1	TRACKING RATTLE *(Lying on back)* Hold **rattle** 12 in. from child's nose. Slowly move rattle in a 90-degree arc to one side (almost to the surface). Return to midline and repeat procedure to other side.	2 Tracks rattle 90 degrees to each side of midline 1 Tracks rattle less than 90 degrees to either or both sides 0 Fixates eyes on rattle for 3 seconds or less				
2	1	TRACKING RATTLE—Side *(Lying on back, head turned to side)* Hold **rattle** 12 in. from child's nose. Slowly move rattle in arc to midline. Repeat with child's head turned to other side.	2 Tracks rattle to midline on both sides 1 Tracks rattle to midline on 1 side only 0 Head remains turned to side				
3	1	PLACING HAND *(Sitting on lap, facing away from table)* Using an upward movement, gently brush the back of child's hand against table edge.	2 Places open hand on table 1 Places fisted hand on table 0 Fails to place hand on table				
4 Start: 3 months	2	PERCEIVING RATTLE *(Lying on back)* Hold **rattle** 12 in. from child's nose. Slowly lower rattle to within 1 in. of nose.	2 Turns head more than 10 degrees 1 Turns head less than 10 degrees 0 Head remains stationary				
5	2	REGARDING HANDS *(Lying on back)* Hold child's hands and wave them in front of face. If child's arms are too short, turn child's head to side and wave 1 hand.	2 Looks at hands for 3 seconds 1 Looks at hands for 1–2 seconds 0 Eyes remain fixed or averted				
6	2	TRACKING BALL—Left to Right *(Sitting on lap, facing table, examiner sits with side to table)* Roll **tennis ball** on table from left to right. Say, "Watch the ball."	2 Tracks ball beyond midline 1 Tracks ball to midline 0 Head remains still				
7 Start: 4 months	2	TRACKING BALL—Right to Left *(Sitting on lap, facing table, examiner sits with side to table)* Roll **tennis ball** on table from right to left. Say, "Watch the ball."	2 Tracks ball beyond midline 1 Tracks ball to midline 0 Head remains still				
8	2	TRACKING RATTLE *(Lying on back with head turned to side)* Hold **rattle** 12 in. from child's nose. Slowly move rattle in a 110-degree arc through midline. Return rattle to side position. Repeat with child's head turned to other side.	2 Tracks rattle through midline on both sides 1 Tracks rattle through midline on one side only 0 Tracks rattle to midline or less				
9 Start: 5–6 months	3	EXTENDING ARMS *(Lying on back)* Shake **rattle** and then hold it 12 in. above child's chest. Say, "Get your rattle."	2 Extends straight arms toward rattle 1 Extends bent arms (90-degree angle or less) toward rattle or extends arms in any direction other than toward rattle 0 Arms remain in same position or continue in same activity				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
10	4	APPROACHING MIDLINE *(Lying on back)* Dangle **toy on a string** 12 in. above child's chest. Say, "Get the toy."	2 Moves hand within 4 in. of midline while reaching for toy 1 Moves hand in any direction except toward midline 0 Fails to move hand				
11 Start: 7 months	4	FINGERING HANDS *(Lying on back)* Hold child's arms between wrist and elbow and bring child's fingers together at midline; then release your hands.	2 Engages fingers in mutual touching for 5 seconds 1 Engages fingers in mutual touching for 3–4 seconds 0 Engages fingers in mutual touching for 0–2 seconds				
12	6	BRINGING HANDS TOGETHER *(Sitting on lap, facing table)* Place **cube** in child's hand. Say, "Play with your block."	2 Brings hands together and secures cube for 15 seconds 1 Brings hands together and secures cube for 1–14 seconds 0 Fails to bring hands together				
13 Start: 8 months	6	EXTENDING ARM *(Lying on back)* Shake and hold **rattle** 12 in. from child's nose. Say, "Get your rattle."	2 Extends arm toward rattle with elbow angle greater than 90 degrees while other arm remains stationary 1 Extends arm toward rattle with elbow angle less than 90 degrees while other arm remains stationary 0 Extends both arms toward rattle				
14	6	RETAINING CUBES *(Sitting on lap, facing table)* **2 cubes** Place **cube** on table and say, "Get the block." After child picks up cube, place **2nd cube** on table. Say, "Get this one, too."	2 Picks up 2nd cube and retains both for 5 seconds 1 Picks up 2nd cube and retains both for less than 5 seconds 0 Picks up only 1 cube				
15	7	TRANSFERRING CUBE *(Sitting on lap, facing table)* **2 cubes** Place **cube** in child's hand. Place **2nd cube** on table within reach of hand already holding cube and as far away as possible from empty hand. Say, "Get this one, too."	2 Transfers cube to other hand and picks up 2nd cube with original hand 1 Transfers cube to other hand and extends either hand to 2nd cube 0 Reaches for 2nd cube without transferring 1st cube				
16 Start: 9 months	7	TOUCHING PELLET *(Sitting on lap, facing table)* Place **food pellet** on table within child's reach. Say, "Get the food."	2 Touches pellet with finger(s) 1 Touches pellet with palm or touches table near pellet 0 Extends hand toward pellet				
17	7	BANGING CUP *(Sitting on lap, facing table)* Bang **cup** 3 times on table; then set it down. Say, "Bang the cup."	2 Bangs cup 3 times 1 Bangs cup 1–2 times 0 Picks up cup but fails to bang				
18 Start: 10 months	8	POKING FINGER *(Sitting on lap, facing table)* Put **pegboard** on table in front of child. Demonstrate poking index finger into hole. Say, "You do it."	2 Pokes finger in hole 1 Places finger within ⅛ in. of hole 0 Touches table or pegboard				
19	8	REMOVING PEGS *(Sitting on lap, facing table)* Place **pegboard** with **3 pegs** loosely inserted in front of child. Say, "Get the pegs."	2 Removes 1 or more pegs 1 Attempts to remove peg 0 Touches pegs				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
20	9	COMBINING CUBES *(Sitting on lap, facing table)* **2 cubes** Place **cube** in child's left hand. Place **2nd cube** near right hand. Say, "Get this one, too, and bang them together." Demonstrate if necessary.	2 Secures 2nd cube and brings cubes together at midline 1 Takes 2nd cube but fails to bring them together at midline 0 Fails to secure 2nd cube				
21	9	CLAPPING HANDS *(Sitting facing examiner)* Clap your hands while you say, "Do pat-a-cake" or "Clap your hands."	2 Claps hands 3 times 1 Claps hands 1–2 times 0 Brings hands together				
22 Start: 11 months	10	RETAINING CUBES *(Sitting on lap, facing table)* **3 cubes** Place **cube in each of child's hands.** After child has retained cubes for 3 seconds, place **3rd cube** on table. Say, "Get this one, too. Hold all the blocks."	2 Extends hand toward 3rd cube while holding both cubes 1 Drops a cube while extending hand to 3rd cube 0 Looks at cube				
23	10	MANIPULATING STRING *(Sitting on lap, facing table)* **Toy on a string** Place **string** on table with **toy** below table and out of sight. Say, "Get the string."	2 Secures string and pulls it 1 Pats string 0 Touches string				
24 Start: 12 months	10	REMOVING PEGS *(Sitting on lap, facing table)* Place **pegboard** with **3 pegs** loosely inserted in front of child. Say, "Take out the pegs."	2 Removes 3 pegs 1 Removes 2 pegs 0 Removes 0–1 peg				
25	10	RELEASING CUBE *(Sitting on lap, facing table)* Place **cube** in child's hand. Say, "Drop the block in my hand." Hold your hand 6 in. below and to the side of child's hand.	2 Releases cube into examiner's hand 1 Drops cube to table 0 Retains cube				
26 Start: 13 months	11	REMOVING SOCKS *(Sitting on floor)* Remove child's shoes and say, "Take off your **socks**."	2 Removes both socks 1 Removes 1 sock 0 Attempts to remove a sock or touches socks				
27	11	PLACING PELLET *(Sitting on lap, facing table)* Place **food pellet and cup** on table. Point to pellet and say, "Put it in the cup."	2 Grasps pellet with thumb and index finger and drops it into cup 1 Grasps pellet with thumb and index finger and extends hand toward cup 0 Grasps pellet				
28	11	PLACING CUBES *(Sitting on lap, facing table)* Place 7 **cubes and cup** on table. Say, "Put the blocks in the cup."	2 Places 3–7 cubes in cup 1 Places 1–2 cubes in cup 0 Fails to place any cubes in cup				
29 Start: 14 months	12	TURNING PAGES *(Sitting on lap or in a safe seated position, facing table)* Place **book with thick cover and thick pages** on table. Say, "Open the book."	2 Opens book 1 Attempts to open book 0 Pats book				
30	12	STIRRING SPOON *(Sitting on lap or in a safe seated position, facing table)* Demonstrate stirring **spoon in cup**. Place spoon next to cup. Say, "Stir with the spoon."	2 Stirs spoon in cup 1 Moves spoon up and down in cup or puts spoon in cup 0 Secures spoon				
31 Start: 15–16 months	12	REMOVING PELLETS *(Sitting on lap or in a safe seated position, facing table)* Give **bottle (without cap) with food pellet inside** and say, "Get it out."	2 Turns bottle and dumps out pellet 1 Attempts to dump out pellet 0 Holds bottle				

Item #	Age In Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
32	13	PLACING CUBES *(Sitting on lap or in a safe seated position, facing table)* Place 7 **cubes and cup** on table. Say, "Put the blocks in the cup."	2 Places 7 cubes in cup 1 Places 4–6 cubes in cup 0 Places 0–3 cubes in cup				
33	13	PLACING PEGS *(Sitting on lap or in a safe seated position, facing table)* Place **pegboard** on table and **3 pegs** between pegboard and child. Say, "Put the pegs in the board."	2 Places 3 pegs in pegboard 1 Places 1–2 pegs in pegboard 0 Picks up pegs				
34	13	TAPPING SPOON *(Sitting on lap or in a safe seated position, facing table)* Demonstrate using horizontal motion to tap **cup** with **spoon**. Place spoon on table. Say, "You do it."	2 Taps cup with horizontal motion 1 Taps cup with vertical motion 0 Picks up spoon				
35	13	INSERTING SHAPES *(Sitting on lap, facing table)* Place **formboard** on table. Place **shapes** between child and board under holes in which they belong. Point to shapes and then to holes and say, "Put the shapes in the board."	2 Places 1 shape into correct hole 1 Places 1 shape partially into correct hole 0 Picks up shape and puts it on board				
36 Start: 17–18 months	14	PLACING PELLET *(Sitting on lap or in a safe seated position, facing table)* Place **bottle** and **4 food pellets** on table. Pick up pellet and put it in bottle. Point to another pellet and say, "Put it in the bottle."	2 Puts pellet in bottle 1 Attempts to put pellet in bottle 0 Picks up pellet				
37	14	SCRIBBLING *(Sitting on lap or in a safe seated position, facing table)* **2 markers and 2 sheets of paper** Draw 2 vertical lines about 3 in. long. Place 2nd sheet of **paper** and **marker** on table. Say, "Do what I did."	2 Makes at least 1 scribble more than 1 in. long 1 Makes scribble less than 1 in. long 0 Touches paper with marker				
38 Start: 19–22 months	15–16	BUILDING TOWER *(Sitting on lap, facing table)* **6 cubes** Say, "Watch me build a tower." Build tower of **3 cubes**. Leave tower standing. Give child **3 cubes** and say, "You build a tower."	2 Stacks 2–3 cubes 1 Attempts to stack 2 cubes 0 Grasps cube				
39	17–18	INSERTING SHAPES *(Sitting on lap, facing table)* Place **formboard** on table. Place **3 shapes** between child and board but not next to correct holes. Point to shapes and then to holes and say, "Put the shapes in the board."	2 Places 2 shapes into correct holes 1 Places 1 shape into correct hole and 2nd shape partially into correct hole 0 Places 1 shape into correct hole				
40 Start: 23–26 months	19–20	BUILDING TOWER *(Sitting on lap or in a safe seated position, facing table)* **10 cubes** Say, "Watch me build a tall tower." Build tower of **5 cubes**. Leave tower standing. Give child **5 cubes** and say, "You build a tall tower."	2 Stacks 4–5 cubes 1 Stacks 3 cubes 0 Stacks 2 cubes				
41	19–20	TURNING PAGES *(Sitting on lap, facing table)* Place **book with thick cover and thick pages** on table. Say, "Look at the book."	2 Turns 3 pages, 1 at a time 1 Turns 2 pages singly or turns 2 or more pages together 0 Opens book				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
42	19–20	INSERTING SHAPES *(Sitting on lap, facing table)* Place **formboard** on table. Place **3 shapes** between child and board but not next to correct holes. Point to shapes and then to holes and say, "Put the shapes in the board."	2 Places 3 shapes into correct holes 1 Places 2 shapes into correct holes and 3rd shape partially into correct hole 0 Places 2 shapes into correct holes				
43 Start: 27–28 months	21–22	BUILDING TOWER *(Sitting on lap or in a safe seated position, facing table)* Say, "Watch me build a tall tower." Build a tower of **6 cubes**. Let tower stand for a few seconds, then knock it down. Give child **6 cubes** and say, "You build a tall tower."	2 Stacks 6 cubes 1 Stacks 5 cubes 0 Stacks 4 cubes				
44	23–24	IMITATING VERTICAL STROKES *(Sitting on lap, facing table)* **2 markers and 2 sheets of paper** Draw 2 vertical lines about 3 in. long. Place 2nd sheet of **paper** and **marker** on table. Say, "Draw a line up and down like I did."	2 Makes stroke 2 in. long and within 20 degrees of vertical 1 Makes stroke 2 in. long and within 21–45 degrees of vertical 0 Makes stroke less than 2 in. long or more than 45 degrees of vertical				
45 Start: 29–30 months	25–26	REMOVING TOP *(Sitting at a table)* Place **food pellet** in **bottle** and screw on **lid**. Give bottle to child and say, "Get the food."	2 Removes lid 1 Attempts to remove lid 0 Shakes bottle				
46	25–26	BUILDING TOWER *(Sitting at a table)* Say, "Watch me build a tall tower." Build a tower of **10 cubes**. Let tower stand for few seconds, then knock it down. Give child **10 cubes** and say, "You build a tall tower."	2 Stacks 8 cubes 1 Stacks 7 cubes 0 Stacks 6 cubes				
47	25–26	SNIPPING WITH SCISSORS *(Sitting at a table)* Cut edge of a piece of paper in 3 places. Give **paper** and **scissors** to child. Say, "You cut the paper."	2 Cuts paper in 1 place 1 Opens scissors and attempts to cut 0 Touches paper with scissors				
48 Start: 31–32 months	27–28	IMITATING HORIZONTAL STROKES *(Sitting at a table)* **2 markers and 2 sheets of paper** Draw 2 horizontal lines 3 in. long. Place 2nd sheet of **paper** and **marker** on table. Say, "Draw a line like I did."	2 Makes stroke 2 in. long and within 20 degrees of horizontal 1 Makes stroke 2 in. long and within 21–45 degrees of horizontal 0 Makes stroke less than 2 in. long or more than 45 degrees from horizontal				
49	27–28	STRINGING BEADS *(Sitting at a table)* **Lace and 6 square beads** String **2 beads** on **lace**. Hand **lace** to child. Put **4 beads** on table and say, "String the beads like I did."	2 Strings 2 beads 1 Strings 1 bead 0 Attempts to string a bead				
50 Start: 33–34 months	27–28	FOLDING PAPER *(Sitting at a table)* **8.5 × 11 in. sheet of paper, cut in half** Fold piece of paper in half and leave it where child can see it. Give child other piece of paper and say, "Fold it like mine."	2 Bends paper, producing a crease 1 Crumples paper 0 Touches paper				
51	29–30	BUILDING TRAIN *(Sitting at a table)* **8 cubes** Build train as pictured in Guide to Item Administration. Push train across table making train sounds. Leave it where child can see it. Put **4 cubes** in front of child and say, "Make a train like mine."	2 Aligns 3 cubes and positions 4th cube on top at one end 1 Aligns 3 cubes but incorrectly positions top cube 0 Aligns 2 cubes				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	
52 Start: 35–38 months	29–30	STRINGING BEADS *(Sitting at a table)* **Lace and 6 square beads** String **2 beads** on **lace**. Hand **lace** to child. Put **4 beads** on table and say, "String all of these beads like I did."	2 Strings 4 beads 1 Strings 3 beads 0 Strings 2 beads				
53	29–30	BUILDING TOWER *(Sitting at a table)* Say, "Watch me build a tower." Build tower of **5 cubes**. Let tower stand for a few seconds, then knock it down. Give child **10 cubes** and say, "Build a tall tower using as many blocks as you can."	2 Stacks 10 cubes 1 Stacks 9 cubes 0 Stacks less than 9 cubes				
54	31–32	BUILDING BRIDGE *(Sitting at a table)* Build bridge with **3 cubes** as pictured in the Guide to Item Administration and leave it standing. Put **3 cubes** in front of child and say, "Build a bridge like mine."	2 Builds bridge as illustrated 1 Builds bridge with bottom 2 cubes touching or top cube out of position 0 Stacks cubes				
55 Start: 39–42 months	33–34	COPYING CIRCLE *(Sitting at a table)* Place **paper, marker,** and **card with circle** on table. Say, "Draw a circle."	2 Draws circle with end points within ½ in. of each other 1 Draws circle with end points ½ to 1 in. of beginning point; circle is at least ¾ complete 0 End points are more than 1 in. apart or circle is less than ¾ complete				
56	35–36	BUILDING WALL *(Sitting at a table)* **8 cubes** Build **4-cube** wall as pictured in Guide to Item Administration and leave standing. Place **4 cubes** in front of child and say, "Build a wall like mine."	2 Builds wall as illustrated or 2 towers touching 1 Builds two 2-cube towers with space between the towers 0 Builds single tower				
57 Start: 43–46 months	37–38	CUTTING PAPER *(Sitting at a table)* Cut piece of **8.5 × 11 in. paper** in half. Give **1 piece of paper** and **scissors** to child. Say, "Cut the paper like I did."	2 Cuts paper into 2 pieces 1 Cuts paper ¾ or less across 0 Snips with scissors				
58	39–40	LACING STRING *(Sitting at a table)* **Lacing strip and lace** Say, "Watch me lace." Lace down through 1st hole, up through 2nd hole. Lace string through 3 holes. Show strip to child, then remove lace and give to child. Say, "You do it like I did."	2 Laces 3 holes 1 Laces 2 holes 0 Puts lace through 0–1 hole				
59	39–40	COPYING CROSS *(Sitting at a table)* Place **paper, marker,** and **card with cross** on table. Say, "Draw lines just like these that cross in the middle."	2 Draws intersecting lines that are within 20 degrees of perpendicular 1 Draws intersecting lines that are more than 20 degrees from perpendicular 0 Fails to intersect lines				
60	41–42	CUTTING LINE *(Sitting at a table)* Give child **paper with 5 × ¼ in. line** and **scissors**. Run your finger along line and say, "Cut on the line."	2 Cuts within ½ in. of line the entire length of line 1 Cuts in direction of line but more than ½ in. from line 0 Snips with scissors				
61 Start: 47–54 months	41–42	COPYING CROSS *(Sitting at a table)* Place **paper, marker,** and **card with cross** on table. Say, "Draw lines just like these that cross in the middle."	2 Draws intersecting lines that are within 20 degrees of perpendicular and lengths on each side of middle vary no more than ¼ in. 1 Draws intersecting lines that are more than 20 degrees from perpendicular and/or lengths on each side of middle vary more than ¼ in. 0 Fails to intersect lines				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3	4
62	41–42	DROPPING PELLETS *(Sitting at a table)* Place **bottle** and **10 food pellets** on table. Say, "Put the food in the bottle as fast as you can. Put only 1 in at a time."	2 Puts 10 pellets in bottle in 30 seconds or less 1 Puts 5–10 pellets in bottle in 31–60 seconds 0 Puts 4 or fewer pellets in bottle in 60 seconds				
63 Start: 55–62 months	41–42	TRACING LINE *(Sitting at a table)* Place **paper with 5 × ¼ in. line** on table with line in horizontal position. Run your finger along the line and say, "Draw on this line. Try to stay right on the line."	2 Deviates off line no more than 2 times and by no more than ½ in. 1 Deviates off line 3–4 times and by no more than ½ in. 0 Deviates off line more than 4 times				
64	49–50	COPYING SQUARE *(Sitting at a table)* Place **paper, marker,** and **card with square** on table. Say, "Draw a square."	2 Draws lines that are straight and within 15 degrees of vertical and horizontal, with closed corners 1 Draws lines that deviate from vertical or horizontal by 16–30 degrees or a corner is open 0 Draws lines that deviate from vertical or horizontal by more than 30 degrees or 2 corners are open				
65	49–50	CUTTING CIRCLE *(Sitting at a table)* Give child **paper with circle on it** and **scissors**. Run your finger around circle and say, "Cut out the circle along the line."	2 Cuts within ¼ in. of line for ¾ of circle 1 Cuts within ½–¼ in. of line for ¼–¾ of circle 0 Cuts out circle more than ½ in. from line				
66 Start: 63–71 months	51–52	BUILDING STEPS *(Sitting at a table)* Build steps as pictured in Guide to Item Administration (**3 cubes** on bottom). Leave steps standing briefly. Then knock down and give **6 cubes** to child. Say, "Build the steps like I did."	2 Builds steps as illustrated 1 Builds steps with space between cubes or without proper alignment 0 Builds structure other than steps				
67	53–54	CONNECTING DOTS *(Sitting at a table)* Place **paper with 2 dots** and **marker** on table. Point to dots and say, "Draw a straight line from 1 dot to the other dot."	2 Connects dots; line does not deviate more than ¼ in. from horizontal 1 Connects dots; line deviates between ¼ and ½ in. from horizontal 0 Fails to connect dots or line deviates more than ½ in. from horizontal				
68	53–54	CUTTING SQUARE *(Sitting at a table)* Give **paper with square on it** and **scissors**. Run your finger around square and say, "Cut out the square along the lines."	2 Cuts out square within ¼ in. of lines 1 Cuts out square within ½–¼ in. of lines 0 Cuts out square more than ½ in. from lines				
69	53–54	BUILDING PYRAMID *(Sitting at a table)* **12 cubes** Build 6-cube pyramid as pictured in Guide to Item Administration and leave standing. Put **6 cubes** in front of child and say, "Build one like mine."	2 Builds pyramid as illustrated 1 Builds pyramid but cubes are touching in some places 0 Builds structure other than pyramid				
70	55–56	FOLDING PAPER *(Sitting at a table)* Show child **8.5 × 11 in. piece of paper folded in half lengthwise** and leave where child can see. Give child **piece of paper** and say, "Fold your paper to look like this one."	2 Folds paper in half with edges parallel and within ⅛ in. of each other 1 Folds paper in half with edges roughly parallel and within ½–⅛ in. of each other 0 Folds paper with edges more than ½ in. of each other				
71	59–60	COLORING BETWEEN LINES *(Sitting at a table)* Place **paper with parallel lines** and **marker** on table. Run your finger back and forth between lines and say, "Color only between the lines."	2 Colors ¾ of space without crossing lines more than 2 times 1 Colors ¾ of space and crosses line 3–4 times 0 Crosses lines more than 4 times				

Item #	Age in Months	Item NAME, *Position*, and Description	Score Criteria	Administration 1	2	3
72	68–72	FOLDING PAPER *(Sitting at a table)* Show child **8.5 × 11 in. piece of paper folded in half twice** and leave where child can see it. Give child **piece of paper**. Say, "Fold your paper to look like this one."	2 Folds paper in half twice with edges parallel and within ⅛ in. of each other 1 Folds paper in half twice with edges parallel and within ¼–⅛ in. of each other 0 Folds paper in half twice with edges more than ¼ in. from each other			

PDMS-2 Profile/Summary Form

Peabody Developmental Motor Scales Second Edition

Section I. Identifying Information

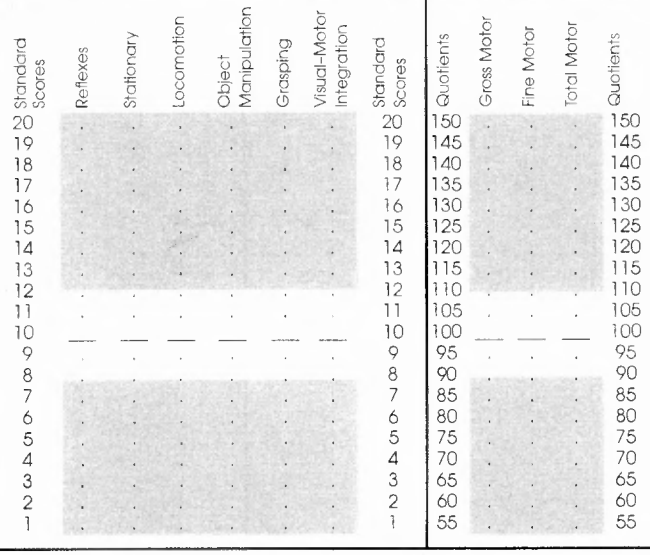
Child's Name _____ Female ☐ Male ☐

	Year	Month	Day	
Date Tested	_____	_____	_____	Examiner's Name _____
Date of Birth	_____	_____	_____	Examiner's Title _____
Chronological Age	_____	_____	_____	
Prematurity Adjustment		— _____	— _____	
Corrected Age	_____	_____	_____	
Age in Months		_____		

Section II. Record of Scores

PDMS-2	*Raw Score*	*Age Equivalent*	*%ile*	*Standard Scores*		
Reflexes	____	____	____	____		____
Stationary	____	____	____	____		____
Locomotion	____	____	____	____		____
Object Manipulation	____	____	____	____		____
Grasping	____	____	____		____	____
Visual-Motor Integration	____	____	____		____	____
Sum of Standard Scores				☐	☐	☐
				GMQ	FMQ	TMQ
Quotients				◯	◯	◯
Percentiles				____	____	____

Section III. Profile of Scores



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800/897-3202, Fax 800/397-7633, http://www.proedinc.com

Subtests	Month at Which 50% of Normat																			
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15–16	17–18	19–20	21–22	23–24	25–25
Gross Motor																					
Reflexes (0–11 months)			1_		2_		3_ 4_ 5_ 6_			7_	8_										
Stationary	1_ 2_	3_ 4_	5_ 6_ 7_	8_ 9_	10_	11_	12_ 13_ 14_	15_		16_	17_ 18_			19_							
Locomotion	1_ 2_ 3_		4_ 5_	6_	7_ 8_ 9_	10_ 11_	12_ 13_ 14_ 15_	16_ 17_	18_	19_ 20_ 21_ 22_ 23_	24_ 25_ 26_ 27_ 28_	29_ 30_ 31_ 32_	33_ 34_ 35_	36_	37_ 38_	39_ 40_	41_ 42_ 43_ 44_	45_ 46_	47_ 48_	49_ 50_ 51_ 52_	53_ 54_ 55_
Object Manipulation (12–72 months)													1_	2_ 3_		4_ 5_		6_ 7_		8_ 9_	10_
Fine Motor																					
Grasping	1_ 2_ 3_		4_ 5_	6_	7_	8_ 9_ 10_	11_ 12_	13_ 14_	15_ 16_ 17_			18_ 19_		20_		21_					
Visual-Motor		1_ 2_ 3_	4_ 5_ 6_ 7_ 8_	9_	10_ 11_		12_ 13_ 14_	15_ 16_ 17_	18_ 19_	20_ 21_	22_ 23_ 24_ 25_	26_ 27_ 28_	29_ 30_ 31_	32_ 33_ 34_ 35_	36_ 37_	38_	39_	40_ 41_ 42_	43_	44_	45_ 46_ 47_

Note. The Stationary and Grasping subtests appear to have periods of time without skill mastery. This is deceiving because this chart is a simplificat most children in the items preceding these areas, when scored 0, 1, and 2, are not conveyed on this chart.

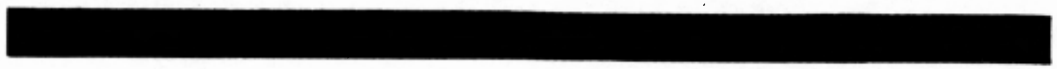
Item Mastery

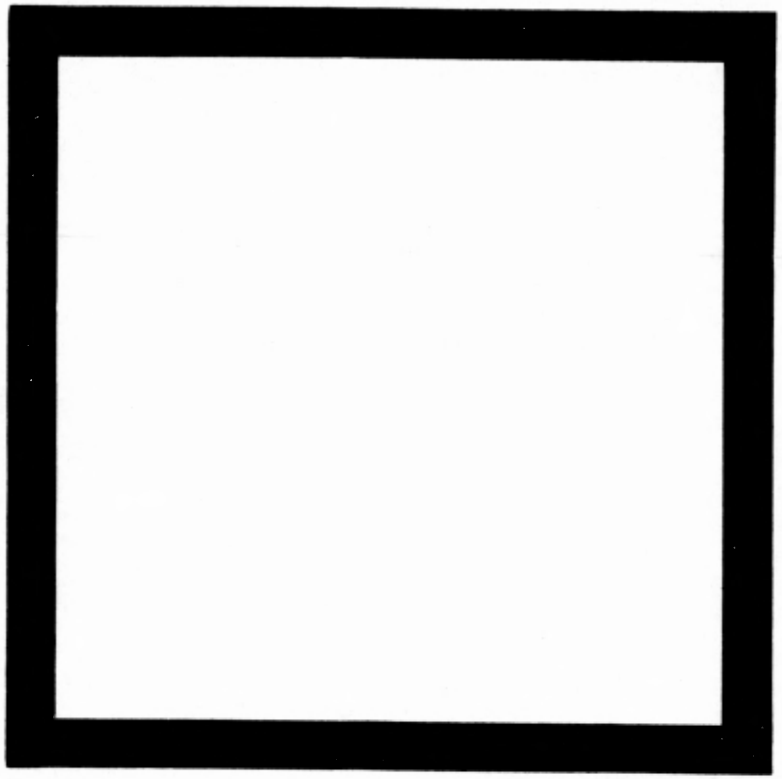
e Met the Criteria for Mastery of Each Item

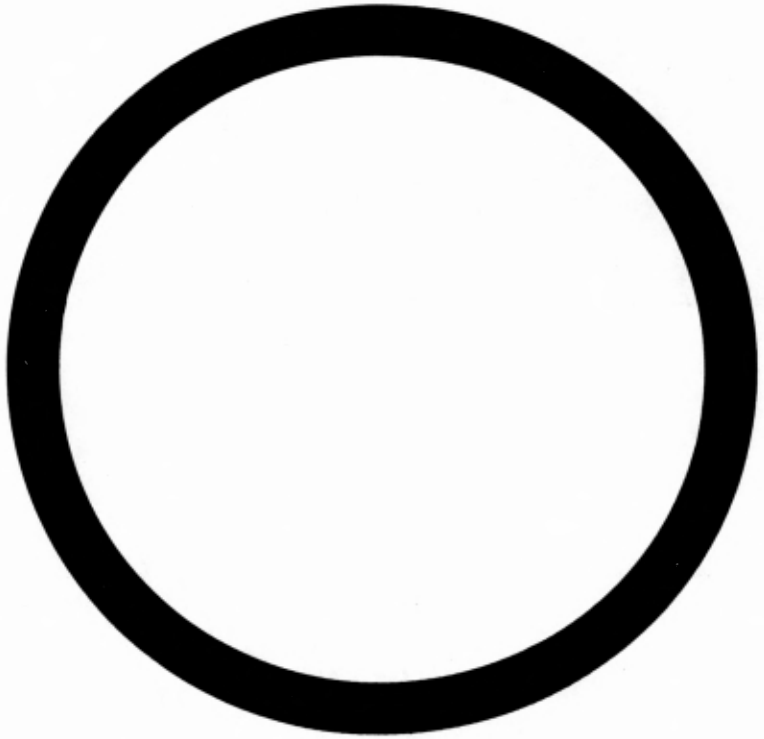
29–30	31–32	33–34	35–36	37–38	39–40	41–42	43–44	45–46	47–48	49–50	51–52	53–54	55–56	57–58	59–60	61–62	63–64	65–67	68–72	72+
	20_					21_	22_	23_			24_	25_ 26_		27_	28_ 29_				30_	31_
58_ 59_ 60_	61_ 62_	63_ 64_	65_	66_	67_	68_ 69_ 70_	71_ 72_	73_ 74_ 75_	76_ 77_		78_ 79_ 80_	81_ 82_ 83_		84_ 85_ 86_	87_	88_	89_			
12_ 13_		14_			15_ 16_	17_	18_	19_ 20_			21_ 22_								23_ 24_	
						22_ 23_			24_	25_		26_								
51_ 52_ 53_	54_	55_	56_	57_	58_ 59_	60_ 61_ 62_ 63_				64_ 65_	66_	67_ 68_ 69_	70_		71_				72_	

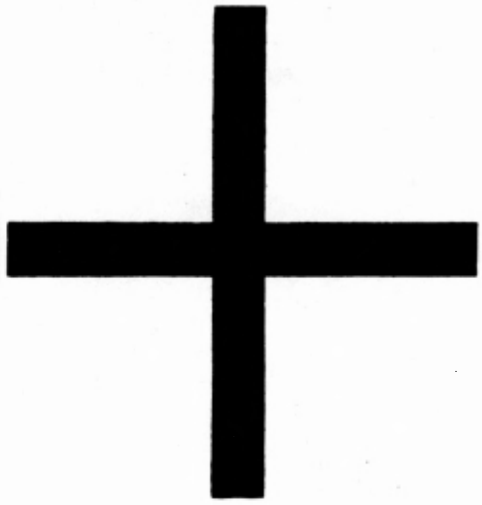
e changes and only shows when 50% of the children sampled mastered the items. Consequently, the qualitative differences taking place for

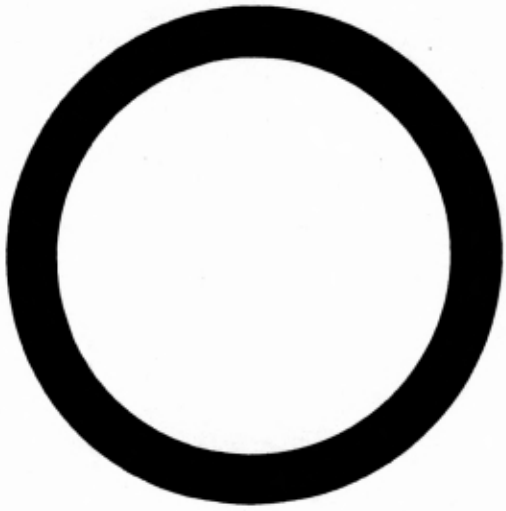
Section V. Referral Information and Recommendations

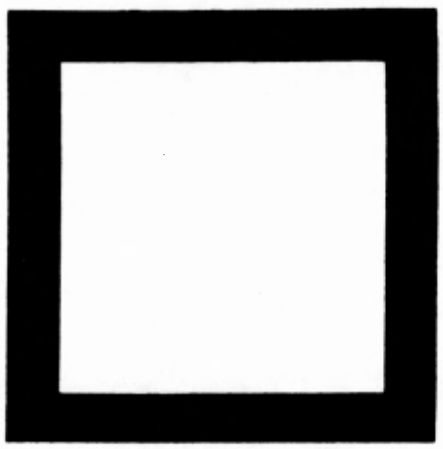




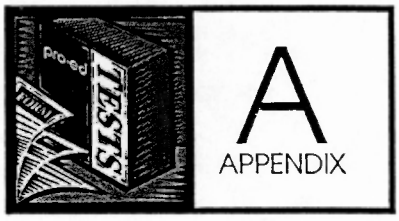








APPENDIX V: PDMS II Reference Tables



Converting Subtest Raw Scores to Percentiles and Standard Scores

Table A.29
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 36–38 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<26	<58	<4	<32	<47	<1
1	26–28	58–73	4–6	32–35	47–59	2
1	29–31	74–90	7–9	36–38	60–71	3
2	32–34	91–98	10–12	39	72–85	4
5	35–36	99–107	13–17	40	86–94	5
9	37–38	108–114	18–19	41	95–98	6
16	39	115–122	20–24	42	99–103	7
25	40	123–129	25–26	43	104–108	8
37	41–42	130–136	27–29	44	109–112	9
50	43–44	137–143	30–32	45	113–116	10
63	45–46	144–148	33–35	46	117–122	11
75	47	149–152	36–38	47	123–125	12
84	48–49	153–156	39–40	48	126–128	13
91	50–51	157–161	41–42	49	129–130	14
95	52	162–166	43	50	131–133	15
98	53–54	167–170	44	51	134–136	16
99	55–56	171–173	45	52	137–138	17
>99	57–58	174–175	46		139	18
>99	59–60	176	47		140	19
>99		>176	48		>140	20

Table A.30
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 39–41 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
1	<27	<59	<5	<33	49	1
<1	27–29	59–74	5–7	33–36	49–61	2
1	30–32	75–92	8–10	37–39	62–74	3
2	33–35	93–101	11–13	40	75–87	4
5	36–37	102–114	14–19	41	88–95	5
9	38–39	115–122	20–21	42	96–103	6
16	40	123–129	22–26	43	104–108	7
25	41–42	130–136	27–29	44	109–112	8
37	43–44	137–143	30–32	45	113–116	9
50	45–46	144–148	33–35	46	117–122	10
63	47	149–152	36–38	47	123–125	11
75	48–49	153–156	39–40	48	126–128	12
84	50–51	157–161	41–42	49	129–130	13
91	52	162–166	43	50	131–133	14
95	53–54	167–170	44	51	134–136	15
98	55–56	171–173	45	52	137–138	16
99	57–58	174–175	46		139	17
>99	59–60	176	47		140	18
>99		177	48		141	19
>99		178			>141	20

Table A.31
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 42–44 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<28	<60	6	<34	<51	1
<1	28–30	60–75	6–8	34–37	51–64	2
1	31–33	76–93	9–11	38–40	65–77	3
2	34–36	94–109	12–14	41	78–91	4
5	37–38	110–120	15–20	42	92–101	5
9	39–40	121–129	21–25	43	102–108	6
16	41–42	130–136	26–29	44	109–112	7
25	43–44	137–142	30–32	45	113–116	8
37	45–46	143–147	33–35	46	117–122	9
50	47	148–152	36–38	47	123–125	10
63	48	153–156	39–40	48	126–128	11
75	49–50	157–161	41–42	49	129–130	12
84	51–52	162–166	43	50	131–133	13
91	53–54	167–170	44	51	134–136	14
95	55–56	171–173	45	52	137–138	15
98	57–58	174–175	46		139	16
99	59–60	176	47		140	17
>99		177	48		141	18
>99		178			142	19
>99					>142	20

Table A.32
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 45–47 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<29	<61	<7	<35	<54	1
<1	29–31	61–76	7–9	35–38	54–67	2
1	32–34	77–94	10–12	39–41	68–80	3
2	35–37	95–112	13–15	42	81–94	4
5	38–40	113–123	16–23	43	95–107	5
9	41–42	124–136	24–28	44	108–112	6
16	43–44	137–141	29–32	45	113–116	7
25	45–46	142–145	33–35	46	117–122	8
37	47	146–150	36–37	47	123–125	9
50	48	151–155	38–39	48	126–128	10
63	49–50	156–161	40–41	49	129–130	11
75	51–52	162–166	42–43	50	131–133	12
84	53–54	167–170	44	51	134–136	13
91	55–56	171–173	45	52	137–138	14
95	57–58	174–175	46		139	15
98	59–60	176	47		140	16
99		177	48		141	17
>99		178			142	18
>99					143	19
>99					144	20

Table A.33
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 48–50 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<30	<62	<8	<36	<57	1
1	30–32	62–77	8–10	36–39	57–70	2
1	33–35	78–95	11–13	40–42	71–84	3
2	36–38	96–116	14–16	43	85–98	4
5	39–41	117–126	17–25	44	99–110	5
9	42–43	127–141	26–31	45	111–113	6
16	44–46	142–145	32–35	46	117–122	7
25	47	146–150	36–37	47	123–125	8
37	48	151–155	38–39	48	126–127	9
50	49–50	156–161	40–41	49	128–130	10
63	51–52	162–166	42–43	50	131–133	11
75	53–54	167–170	44	51	134–136	12
84	55–56	171–173	45	52	137–138	13
91	57–58	174–175	46		139	14
95	59–60	176	47		140	15
98		177	48		141	16
99		178			142	17
>99					143	18
>99					144	19
						20

Table A.34
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 51–53 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	≤31	≤63	≤9	≤37	≤60	1
1	32–33	64–78	10	38–40	61–73	2
1	34–36	79–98	12–14	41–43	74–87	3
2	37–39	99–120	15–17	44	88–102	4
5	40–42	121–133	18–26	45	103–114	5
9	43–44	134–145	27–32	46	115–121	6
16	45–47	146–150	33–36	47	122–125	7
25	48	151–155	37–38	48	126–127	8
37	49–50	156–161	39–40	49	128–130	9
50	51–52	162–166	41–42	50	131–135	10
63	53–54	167–170	43–44	51	134–136	11
75	55–56	171–173	45	52	137–138	12
84	57–58	174–175	46		139	13
91	59–60	176	47		140	14
95		177	48		141	15
98		178			142	16
99					143	17
>99					144	18
>99						19
						20

Table A.35
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 54–59 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<32	<64	<10	<37	<63	<1
1	35–37	81–102	13–15	41–43	77–91	3
2	38–40	103–123	16–18	44	92–106	4
5	41–43	124–138	19–22	45	107–118	5
9	44–45	139–150	23–34	46	119–125	6
16	46–48	151–155	35–38	47	124–127	7
25	49–50	156–161	39–40	48	128–130	8
37	51–52	162–166	41–42	49	131–133	9
50	53–54	167–170	43–44	50	134–136	10
63	55–56	171–173	45	51	137–138	11
75	57–58	174–175	46	52	139	12
84	59–60	176	47	53	140	13
91		177	48		141	14
95		178			142	15
98					143	16
99					144	17
>99						18
>99						19
						20

Table A.36
Converting Subtest Raw Scores to Percentiles and Standard Scores

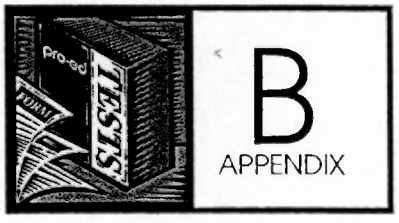
Age 60–65 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<33	<65	11	<38	<66	1
<1	33–35	65–81	11–13	38–41	66–79	2
1	36–38	82–105	14–16	42–44	80–94	3
2	39–41	106–125	17–19	45	95–110	4
5	42–44	126–141	20–28	46	111–120	5
9	45–47	142–155	29–35	47	121–126	6
16	48–50	156–161	36–39	48	127–130	7
25	51–52	162–166	40–41	49	131–133	8
37	53–54	167–170	42–43	50	134–136	9
50	55–56	171–173	44–45	51	137–138	10
63	57–58	174–175	46	52	139	11
75	59–60	176	47		140	12
84		177	48		141	13
91		178			142	14
95					143	15
98					144	16
99						17
>99						18
>99						19
>99						20

Table A.37
Converting Subtest Raw Scores to Percentiles and Standard Scores

Age 66–71 Months

Percentile Rank	PDMS-2 Subtests					Standard Scores
	Stationary	Locomotion	Object Manipulation	Grasping	Visual-Motor	
<1	<34	<66	<12	<38	<68	1
1	34–36	66–82	12–14	38–41	68–82	2
1	37–39	83–108	15–17	42–44	83–97	3
2	40–42	109–127	18–20	45	98–112	4
5	43–45	128–145	21–29	46	113–121	5
9	46–48	146–161	30–36	47	122–129	6
16	49–52	162–166	37–40	48	130–133	7
25	53–54	167–170	41–42	49	134–136	8
37	55–56	171–173	43–44	50	137–138	9
50	57–58	174–175	45–46	51	139	10
63	59–60	176	47	52	140	11
75		177	48		141	12
84		178			142	13
91					143	14
95					144	15
98						16
99						17
>99						18
>99						19
>99						20



Converting Sums of Standard Scores to Percentiles and Quotients

Table B.1
Converting Sums of Subtest Standard Scores to Percentiles and Quotients

Percentile Rank	Total Motor (5 Subtests)	Gross Motor (3 Subtests)	Fine Motor (2 Subtests)	Quotient
>99	>95	—	—	165
>99	—	60	—	164
>99	—	59	—	162
>99	95	—	—	161
>99	94	58	40	160
>99	93	57	—	158
>99	92	—	39	157
>99	91	56	—	156
>99	90	55	38	154
>99	89	—	—	153
>99	88	—	—	152
>99	—	54	37	151
>99	87	—	—	150
>99	86	53	—	149
>99	85	—	36	148
>99	—	52	—	147
>99	84	—	—	146
>99	83	51	35	145
>99	82	50	—	143
>99	81	—	34	142
>99	80	49	—	141
>99	79	48	33	139
>99	78	—	—	138
>99	77	—	—	137
>99	—	47	32	136
99	76	—	—	135
99	75	46	—	134
99	74	—	31	133
99	—	45	—	132
98	73	—	—	131

(continues)

Table B.1 *Continued.*

Percentile Rank	Total Motor (5 Subtests)	Gross Motor (3 Subtests)	Fine Motor (2 Subtests)	Quotient
98	72	44	30	130
97	71	43	—	128
97	70	—	29	127
96	69	42	—	126
95	68	41	28	124
94	67	—	—	123
93	66	—	—	122
92	—	40	27	121
91	65	—	—	120
90	64	39	—	119
89	—	—	26	118
87	63	38	—	117
86	62	—	—	116
84	61	37	25	115
81	60	36	—	113
79	59	—	24	112
77	58	35	—	111
73	57	34	23	109
70	56	—	—	108
68	55	—	—	107
65	—	33	22	106
63	54	—	—	105
61	53	32	—	104
58	52	—	21	103
55	—	31	—	102
53	51	—	—	101
50	50	30	20	100
45	49	29	—	98
42	48	—	19	97
39	47	28	—	96
35	46	27	18	94
32	45	—	—	93

(continues)

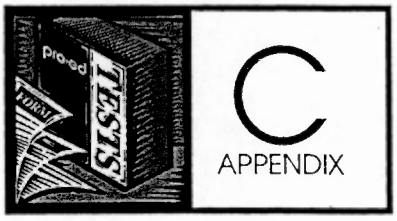
Table B.1 *Continued.*

Percentile Rank	Total Motor (5 Subtests)	Gross Motor (3 Subtests)	Fine Motor (2 Subtests)	Quotient
30	44	—	—	92
27	—	26	17	91
25	43	—	—	90
23	42	25	—	89
21	41	—	16	88
19	—	24	—	87
18	40	—	—	86
16	39	23	15	85
13	38	22	—	83
12	37	—	14	82
10	36	21	—	81
8	35	20	13	79
7	34	—	—	78
6	33	—	—	77
5	—	19	12	76
5	32	—	—	75
4	31	18	—	74
3	30	—	11	73
3	—	17	—	72
3	29	—	—	71
2	28	16	10	70
1	27	15	—	68
1	26	—	9	67
1	25	14	—	66
<1	24	13	8	64
<1	23	—	—	63
<1	22	—	—	62
<1	—	12	7	61
<1	21	—	—	60
<1	20	11	—	59
<1	19	—	6	58
<1	—	10	—	57
<1	18	—	—	56

(continues)

Table B.1 *Continued.*

Percentile Rank	Total Motor (5 Subtests)	Gross Motor (3 Subtests)	Fine Motor (2 Subtests)	Quotient
<1	17	9	—	55
<1	16	8	—	54
<1	15	—	4	52
<1	14	7	—	51
<1	13	—	3	49
<1	12	6	—	48
<1	11	—	—	47
<1	—	—	2	46
<1	10	5	—	45
<1	9	—	—	44
<1	8	4	—	43
<1	7	3	—	41
<1	6	—	—	40
<1	5	—	—	38



Converting Raw Scores to Age Equivalents

St = Stationary
Lo = Locomotion
Re = Reflexes
Ob = Object Manipulation
Gr = Grasping
Vi = Visual-Motor Integration

Table C.1
Converting Raw Scores to Age Equivalents

Age Equivalent in Months	PDMS-2 Subtests						Age Equivalent in Months
	Re	St	Lo	Ob	Gr	Vi	
1	1	1-12	1-7	—	1-8	1-7	1
2	2	13-15	8-11	—	9-11	8-12	2
3	3	16-18	12-16	—	12-14	13-16	3
4	4	19-21	17-22	—	15-19	17-19	4
5	5-6	22-24	23-27	—	20-24	20-22	5
6	7-10	25-26	28-33	—	25-28	23-28	6
7	11-12	27-29	34-39	—	29-31	29-34	7
8	13	30-31	40-47	—	32-33	35-39	8
9	14	32-33	48-54	—	34-35	40-45	9
10	15	34-35	55-60	—	36	46-52	10
11	16	36	61-64	—	37	53-58	11
12	—	—	65-68	1-4	38	59-64	12
13	—	—	69-71	5-6	39	65-68	13
14	—	37	72-76	7	40	69-72	14
15	—	—	77-80	8-9	41	73-75	15
16	—	—	81-84	10	—	76	16
17	—	—	85-88	11	—	77-78	17
18	—	38	89-91	12	—	79-81	18
19	—	—	92-93	13	—	82-84	19
20	—	—	94-96	14	42	85-86	20
21	—	39	97-98	15	—	87-88	21
22	—	—	99-102	16-17	—	89-90	22
23	—	—	103-107	18-19	—	91-94	23
24	—	—	108-109	20	—	95	24
25	—	—	110-112	21	—	96-97	25
26	—	—	113-114	22	—	98	26
27	—	—	115-116	23	—	99-100	27
28	—	40	117-119	24	43	101-102	28
29	—	—	120-122	25	—	103	29
30	—	—	123-124	26	—	104-105	30
31	—	—	125-127	—	—	106-107	31
32	—	—	128-129	27	—	108	32
33	—	41	130-131	28	—	109	33
34	—	—	132-134	29	44	110-111	34
35	—	42	135-136	—	—	112	35
36	—	—	137-138	30	—	113	36

(*continues*)