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The Effect of Familiar and Novel Testing Environments on the Gross Motor Function Measure Scores of Developmentally Normal Children 17-37 Months Old

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THE EFFECT OF FAMILIAR AND NOVEL TESTING ENVIRONMENTS ON THE GROSS MOTOR FUNCTION MEASURE SCORES OF DEVELOPMENTALLY NORMAL CHILDREN 17-37 MONTHS OLD

by
Tracey Blain and Jean Angel
April 22, 1998
THE EFFECT OF FAMILIAR AND NOVEL TESTING ENVIRONMENTS ON THE GROSS MOTOR FUNCTION MEASURE SCORE OF DEVELOPMENTALLY NORMAL CHILDREN 17-37 MONTHS OLD

by

Jean Angel
Tracey Blain

THESIS

Submitted to the Department of Physical Therapy at Grand Valley State University Allendale, Michigan in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN PHYSICAL THERAPY

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ABSTRACT

Our purpose in this research was to compare the reliability of the Gross Motor Function Measure in familiar and unfamiliar environments. Discrepancy between clinical assessment results and true motor functional ability may give false information leading to inefficient treatment sessions. Our research gives therapists information about optimal assessment site choice. Subjects included sixteen developmentally normal children between the ages of 17 and 37 months. Our study fit a repeated measure counterbalanced design, and ANOVA was used to analyze our data. We did not reject our null hypothesis that the child’s score on the GMFM in the familiar environment would equal that of the unfamiliar environment.
DEDICATION

We dedicate this thesis to our husbands, Andy and Tom. Thank you for your unending support. And lastly, we must not forget Ivan and Gretta, two lovable rottweilers, that were always there to give us unconditional love.
ACKNOWLEDGMENTS

We would like to thank Dr. Peck and his students in Arkansas for giving us the idea for this thesis. Additionally we would like to thank Dr. Peck for chairing our committee and Dr. Neal Rogness and Professor Barb Baker for their guidance. Your advice, draft revisions, and feedback were invaluable. Finally, we would like to thank our subjects and their families for their participation in this research.
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OPERATIONAL DEFINITION OF TERMS

Repeated measure – An independent variable for which subjects act as their own control; that is all subjects are exposed to all levels of the variable.

Counterbalancing – Systematic alterations of the order of treatment conditions, to avoid order effects in a repeated measure design.

Stranger – A person the child does not interact with more than twice a year.

Familiar environment – An environment in which a child spends more than 10 hours per week.

Unfamiliar or novel environment – An environment a child has never experienced.

Developmentally normal – Children who have not been identified by health care providers as having developmental delays of motor function.

Responsiveness – The ability to detect change.
CHAPTER 1
INTRODUCTION

Physical therapists use pediatric assessment tests to determine motor functional abilities of children with and without disabilities. Therapists set goals and track a child's progress with data collected from assessment tests. Problems may arise with pediatric assessment tests that can threaten the validity of results. A factor that could alter test results is the environment in which the test is administered. Two types of environments to consider include familiar and unfamiliar.

Frequently, therapists perform assessment tests in a setting unfamiliar to children such as a clinical exam room or a hospital room. Therapists question the degree to which the children's motor demonstration in unfamiliar environments is representative of their true motor functional abilities. For example, children demonstrate different behaviors at home and at school. Children demonstrate higher physical activity levels (e.g. sitting, standing, and moving arms and legs) at school (Marturano, 1980). If this difference exists between children's behavior at home and in a clinic, then discrepancy between true motor functional ability and clinical assessment may result. Therefore, therapists may receive inaccurate information that would lead to incorrect evaluative judgements and inefficient treatment sessions. In our study, we compared pediatric assessment test results obtained in familiar and unfamiliar environments to determine the effects of these environments on test results.

An instrument, that was developed for measuring gross motor functional changes in children with cerebral palsy, is the Gross Motor Function Measure (GMFM).
The GMFM is the pediatric assessment test chosen for our study as this tool is very effective in responding to change over time in gross motor function of children. Test activities are based on motor function maturation of normal children in order to capture the developmental changes occurring naturally in children, while at the same time being sensitive to the specific deficits resulting from cerebral palsy (Russell et al., 1994).

The GMFM is an assessment tool therapists use to "1) describe a child's current level of motor function, 2) determine treatment goals, and 3) provide easy explanations to parents concerning their child's progress" (Russell et al., 1993). The five dimensions of motor function in the GMFM include: 1) lying and rolling, 2) sitting, 3) crawling and kneeling, 4) standing, and 5) walking, running, jumping. In assessing GMFM scores, therapists learn the quantity of an activity a child can do regardless of quality of movement (Russell et al., 1993). While researchers have demonstrated the intra-tester and inter-tester reliability of the GMFM, no information exists on the reliability of the GMFM across unfamiliar and familiar environments (Gowland et al., 1995).

Physical therapy research concerning test environment is necessary because researchers in the field of psychology have determined that children behave differently in familiar and unfamiliar environments. Children show distress and less exploratory behavior when in a novel environment. Children's attachment behavior (behaviors promoting contact such as crying, clinging, approaching, following, smiling, and calling) increases in the absence of the mother and in the presence of strangers in a novel
environment (Ainsworth and Bell, 1970).

In our study, we compare GMFM scores in familiar and unfamiliar environments in developmentally normal children between the ages of 17-37 months. Our study gives therapists information on which to base optimal assessment site choice for assessing true motor functional ability. We measured children’s motor function (response variable) using the GMFM in familiar and unfamiliar settings (treatment variable) and compared the child’s GMFM score in the familiar environment with their score in an unfamiliar environment. The null hypothesis is that the child’s score on the GMFM in the familiar environment would equal that of the score in the unfamiliar environment. Acceptance of the null hypothesis indicates that children’s familiarity with environment does not effect the reliability of GMFM score. Conversely, rejection of the null hypothesis indicates that GMFM test results are not reliable across environments for our subjects. Clinically, this suggests that children examined in the home, who performed well and did not qualify for physical therapy services, may not perform as well in the clinic and would qualify for these same services.
Physical therapists use pediatric assessment tests to determine motor functional levels in children with physical disabilities. These tests measure developmental age equivalence of the child and attainment of motor milestones. In the following paragraphs, we develop the rationale for our hypothesis. We cite relevant literature regarding the GMFM, testing environment, effect of caregiver presence during testing, stranger anxiety, caregiver report of child behavior, learning effects, and children with special needs.

**Gross Motor Function Measure**

The Gross Motor Function Measure (GMFM) is a criterion-referenced, evaluative, pediatric assessment tool that measures change in gross motor function over time or after treatment. This tool assesses whether or not a child can independently complete a motor task regardless of motor performance such as stability or efficiency (Boyce, Gowland, & Rosenbaum, 1991). Physical therapists use this test to evaluate children diagnosed with cerebral palsy. Though the GMFM was designed to assess children with special needs, test activities are based on normal developmental milestones (Appendix F) to monitor motor delays or plateaus and pathological movement or motor regression, that may occur with a child diagnosed with cerebral palsy (Russell et al., 1993).

Test activities consist of 88 items in five dimensions of motor function including: 1) lying and rolling, 2) sitting, 3) crawling and kneeling, 4) standing, and 5)
walking, running, and jumping. Clinicians chose test items based on a literature review and judgment of clinicians in participating centers. Testers observe motor function and determine the child's score based on a four point scale: 0 = cannot initiate task, 1 = initiates task, 2 = partially completes task, and 3 = completes task (Russell et al., 1993).

**GMFM Responsiveness to Change in Level of Gross Motor Function**

Boyce et al. (1991) classified the GMFM as an evaluative measure with the essential purpose of accurately detecting a change in motor function. This group defined responsiveness as the capability to detect change. These researchers identified responsiveness as "a key feature an instrument should possess to determine its usefulness as an evaluative measure." An evaluative measure must demonstrate responsiveness to change even if that change is small (Boyce et al., 1991).

Researchers determined that the GMFM is superior to other norm-referenced scales such as the Peabody Developmental Motor Scales, the Bruininks-Oseretsky Test of Motor Development or the Bayley Motor Scale in assessing change of gross motor function over time (McLaughlin et al. 1994, Rosenbaum et al. 1990). These researchers tested thirty-four children with the diagnosis of spastic quadriplegia; subjects ages ranged from 6 to 36 years old with an average age of 13 years old. The focus of McLaughlin and colleagues prospective study was to identify the role of selective dorsal rhizotomy (SDR) in cerebral palsy. Subjects received intensive physical therapy following SDR. Researchers recorded GMFM results before and after SDR procedure. McLaughlin et al observed clinically and statistically significant levels of improvement in gross motor
function with the second application of the GMFM.

Russell et al. (1989) designed their study “to validate the GMFM for its capability of detecting change in motor function (responsiveness to change).” Subjects consisted of 111 children < 20 years old with the diagnosis of cerebral palsy, 25 children age unknown with a head injury diagnosis, and 34 children < 5 years old with no known motor handicaps. Researchers included the latter subject population to indicate how much change could be expected during normal development. The test was completed twice within a four to six month interval. Parents and therapists independently rated the subject’s function within two weeks of the initial assessment. Researchers videotaped subjects during evaluation to allow for a “blind” evaluation by therapists. Researchers correlated scores of parents, therapists and “blind” evaluators and showed that the GMFM was responsive to both positive and negative changes.

GMFM Reliability and Validity

Portney and Watkins (1993) define reliability and validity as follows: Reliability is the “degree of consistency with which an instrument or rater measures a variable.” Validity is “1. The degree to which an instrument measures what it is intended to measure. 2. The degree to which a research design allows for reasonable interpretations from data, based on controls (internal validity), appropriate definitions (construct validity), appropriate analysis procedures (statistical conclusion validity), and generalizability (external validity).” The following researchers have shown the reliability and validity of the GMFM.
Drouin et al. (1996) correlated GMFM scores and spatiotemporal measures of gait in children with neurologic impairments. Subjects included thirty children between the ages of 1 and 8 years old. These researchers assessed gait and motor performance of each child using a videographic gait test and the GMFM. Researchers calculated a correlation of 0.899 between gait velocity and GMFM scores and attributed their findings of high validity to the use of standardized protocol when administering the test. Intra-rater reliability was established prior to the study with all physical therapists achieving the criterion value with an average kappa value of 0.94. Scores ranged from 0.84 to 0.97.

Russell et al. (1989), in their previously mentioned study, established the validity and reliability of the GMFM. For intra- and inter-rater reliability, the Intraclass Correlation Coefficient ranged from 0.87 to 0.99 with the acceptability level greater than or equal to 0.75. Validity that non-disabled children under 3 years old will show more change than non-disabled children 3 years or older was shown with \( t \) \( [29] = 4.5 \). A probability value of \( p < 0.0001 \) was an acceptable level.

Damiano and Abel (1996) used the GMFM to study the relationship between gait analysis and gross motor function in thirty-two children diagnosed with spastic quadriplegia. Researchers used multiple regression statistical analyses to assess relationships among gait parameters and GMFM scores. Researchers showed that the GMFM is a valid indicator of motor function and gait in cerebral palsy.

These previous studies show that intra- and inter-rater reliability has been demonstrated in multiple studies. Validity, especially regarding children less than 3 years
old, has been established for the GMFM. This information was used when we chose a test that would accurately and efficiently meet the proposed hypothesis and the underlying criteria. We also were confident that intra- and inter-rater reliability could be established between current student investigators based on the reliability data in previous studies.

**Home-based vs. Clinic-based Interventions and Testing Environment**

Providers of services such as physical therapy basically work in two environments: 1) in the child’s home or 2) in a community center such as a hospital or school. Garwood and Fewell (1983) cite Kelly and list advantages of a home based program:

“1) Parents feel comfortable in their own home and therefore act more like themselves. 2) Similarly children are more likely to perform better in their own home. 3) The health of the child is better protected. 4) Parent and child routines are not disrupted. 5) There is more likelihood of being able to include other members of the family in intervention efforts. 6) Sessions are more regular; there is not as great an attendance problem. 7) The natural environment of the child and parent may be used and modified to facilitate development”

Limited research exists regarding service setting. Bronfenbrenner, as reported by Friedlander et al., suggests that home-based or home-based plus center-based programs are more effective than center-based programs alone (Friedlander, Sherrit, & Kirk, 1975).

Park, Fisher, and Velozo (1994) show that environment does effect performance of process skills in adults. These researchers examined the effect of home versus clinic settings on the instrumental activities of daily living (IADL) performance of older adults. These researchers evaluated twenty older adults in their homes and in an
occupational therapy clinic using the Assessment of Motor and Process Skills (AMPS). Motor skills are defined as, “the observable operations or actions that are thought to be related to underlying postural control, mobility, coordination and strength.” Process skills are defined as, “the actions used to organize and adapt logically a series of actions over time in order to complete a specified task. Process skills are thought to be related to underlying attentional, conceptual, organizational and adaptive capabilities of a person.”

Adults demonstrate higher scores on process skill in familiar environments while motor skill scores remain stable across environments (Park, Fisher, & Velozo, 1994). The GMFM is a test that primarily measures motor function; however, the GMFM does require children to use process skills such as attending to a task and organizing the sequence of activities. For example, in question 70 of the GMFM, the child must walk forward 10 steps, stop, turn 180 degrees and return. The child must attend to the examiner’s description of the test and perform these items in order.

Weir and May (1988) found similar results when testing college age students. Researchers tested two different sets of 52 college undergraduates. Each group received lecture in one room and was tested in another. The dependent factors were the environmental differences of the test rooms. Group A was tested in an environment with minimal differences; the test room was similar to the lecture room but in a different building. Group B was tested in a substantially different environment than the lecture room: desk size, room color, lighting, paint, and floor plan were all different. Results showed students performed better when tested in the familiar room in which the lectures
were given versus that of testing in an unfamiliar room.

Although we explored the effect of environment on children, we feel justified in relating the previous two adult studies to our research on children. Children develop into adults, and in some way, adult skills reflect on child skills. In addition, there is a lack of research on testing environment and effects on children.

In summary, this research suggests that children may perform better on the GMFM in a familiar environment. In our research we explore advantage number two of home-based programs (children are likely to perform better in a home environment). We determine the effect of testing site on children’s GMFM score.

**Presence of Caregiver and Effects on Child’s Behavior during Testing**

Ainsworth and Bell (1970) studied the effect of a novel testing site and the presence of children’s mothers on the children’s exploration behavior. These researchers call this novel environment the “strange” situation. The “strange” situation was designed to be novel enough to elicit exploratory behavior but not so strange that it evoked fear and heightens alarm. Ainsworth and Bell designed an environment to become progressively more stressful to their child-subjects; though it was not more stressful than everyday life environments the child would be likely to encounter. These researchers studied 56 white, middle class, 49-51 week old infants in a “strange” situation with the changes in the testing environment proceeding in the following order: First with the mother present, then with the mother and a stranger present, then with a stranger present, then with the mother present, then with no one present, and finally with the stranger present again. Ainsworth
and Bell used a "strange" situation instead of a home environment because only a novel environment would produce the condition of novelty and alarm. These researchers found that the presence of the child's mother encouraged the child to explore while her absence decreased exploration and heightened attachment behavior (behaviors promoting contact such as crying, clinging, approaching, following, smiling, and calling). While the baby's exploration increased with the mother present, exploration decreased when a stranger was present.

The work of Belkin and Routh (1975) supported these results of Ainsworth and Bell in their study with three-year-old children. Children's attachment behavior increased in the absence of the mother and in the presence of strangers in a novel environment.

Because of this research, we have our subject's caregivers present during our experiment for all testing. The term caregiver is stated versus mother in recognition that the mother may not always be the primary caregiver to a child. Presence of the caregiver may encourage a child to explore and decrease attachment behaviors therefore allowing student investigators to more efficiently complete assessment testing with a content child.

**Stranger Anxiety**

The research cited in the previous section shows that a baby's exploration of his/her environment decreases in the presence of a stranger and in a novel environment. Not surprisingly, at approximately eight months of age, children begin to experience stranger anxiety. H. R. Schaffer (1966) studied 36 infants and found them to show fear
reactions in the presence of strangers at an average of 8 months of age. Because the presence of a stranger does effect children's comfort level and exploratory behavior, we designed our study so that our subjects are tested by a stranger in both the familiar testing environment and the unfamiliar testing environment in the presence of their caregiver. Thus the effect of the stranger will be constant and minimize effects on our results.

Care-Giver Report of Child Behavior

Another factor that can influence child exploration is child behavior. Physical therapists may utilize parent or caregiver report of their child's behavior to determine when behavior is out of the ordinary. This information can be useful in a testing or treatment environment when the therapist is not familiar with a child and his or her typical behavior. Parent report of their child's behavior is valuable to the therapist as the parent has greater knowledge than the therapist regarding the situational context of their child's behavior. The parent also may know certain environments where their child may encounter distress (Connors, 1989). In pediatric assessment, use of behavior assessment scales in specific testing situations may provide information to the therapist regarding typical behavior and help identify behaviors that are out of the ordinary for the child. This atypical behavior may influence testing procedure and/or the corresponding test results if, for example, the child will not or can not complete the test items.

Connors' Parent and Teacher Rating Scales are standardized behavior assessment scales that are used to characterize a child's behavior. These scales have dual functions: measurement of major types of behavior problems and a routine screening
device to identify behavior problems in children. With the latter function, potential use of these scales applies to a number of settings including schools, outpatient clinics, inpatient clinics, residential treatment centers, and child protective services (Connors, 1989). Parents or teachers (or both) fill out the appropriate scale as required for the testing situation. Scoring consists of four response items specific to the questions under each category. Responses are scored as follows: 1 = not at all, 2 = just a little, 3 = pretty much, and 4 = very much. Multiple behavior categories are identified on the Connors' Parent Rating Scales. In our research, we will use the Connors' Parent Rating Scale (CPRS) to ask questions that identify anxious-shy behaviors in children. We hope to identify behavior patterns that may not be ideal for gross motor function testing when children are asked to independently perform motor tasks identified by a stranger.

The Connors' Parent Rating Scale - 93 (CPRS - 93), the long form version, will be abbreviated by student investigators to isolate questions that indicate behavior patterns of anxious-shy. C. Keith Connors, the author of the CPRS - 93, identified that this active research instrument was chosen for use in hundreds of studies in more than a dozen countries and was frequently modified by individual investigators (Connors, 1989). As reported in the Connors' Rating Scales manual (1989), research literature supports overall basic results from the Connors' Rating Scales to be "so robust that minor variations in methodology from one study to another have not affected the overall conclusions of the research." The CPRS was also reviewed by the Connors' Rating Scales Manual (1989) as a multidimensional instrument with adequate reliability and
validity. Connors also states that the CPRS maintains a wide age range of applications with good normative data. Test-retest reliability has been shown to be .70 by Glow, Glow, and Rump (1982). Connors (1973) found that mother-father correlation for the CPRS averaged 0.85. These previous studies are a few examples that show the Connors’ Parent Rating Scale will be a successful tool in determining behaviors of anxiousness and shyness.

With the CPRS, student investigators accept the parent’s responses to questions at face value. Parent’s responses to questions will be considered a sample of parent-report behavior without inferring or generalizing to broader dimensions of child personality and social behavior.

McCall, Parke, and Kavanaugh (1970) support Connors’ (1989) work. These researchers showed that socially extroverted 3-year-old children imitated live models more than shy children did. These studies suggest that more socially extroverted children may have higher GMFM scores as these children may imitate gross motor skills better than shy children.

Student researchers addressed issues of behavior through administration and analysis of Connors’ Parent Rating Scale and resultant effects on a child’s GMFM score. Behavior may have effect ed a child’s response during testing. Therefore, the child’s score on a pediatric assessment test, such as the GMFM, was effected by these external factors.
Deferred Imitation and Learning Effects

Andrew Meltzoff studied deferred imitation after a one-week delay in 14-month-old infants. Researchers demonstrated six different actions, each using a different object for each action. Infants observed the demonstration of the six actions and were not allowed to touch the objects. The imitation condition subjects produced more performance of the demonstrated actions than the control group who was not exposed to the modeling of the actions. These infants Meltzoff studied simply observed the actions and demonstrated a learning effect. Therefore, the children in our study, who were each tested twice and had an opportunity not only to observe but to practice imitated actions, may have shown a learning effect and performed better on the second testing experience (Meltzoff, 1988). This learning effect may have threatened the validity of our data as the GMFM scores of our subjects could have been attributed to the learning effect compared to the difference of the environment.

Because of this information, we designed our study to control for learning effects bias. Half the subjects were tested in the familiar environment first and the second half were tested in the unfamiliar environment first.

Children with Special Needs

One limitation of our study is that this research cannot be used to predict how a child with special needs will score on the GMFM in a strange versus a familiar situation. Serafica and Cicchetti (1976) studied children with Down’s syndrome in strange situations and compared them with normal children in strange situations. These
researchers discovered that children with Down’s syndrome demonstrate less attachment behavior than children without Down’s syndrome. In this study special needs children differed from other children in attachment behaviors in that special needs children demonstrated less proximity seeking behavior such as crying than children without Down’s syndrome. Children with special needs often behave differently than other children (Serafica & Cicchetti, 1976). Because the present study did not include children with special needs, GMFM results in familiar and unfamiliar environments may not apply to children with cerebral palsy.

**Conclusion of Literature Review**

Although we hypothesize that the child’s score on the GMFM in the familiar environment will equal the score in an unfamiliar environment, literature suggests that test results will be unequal in different environments. Literature on home-based versus clinic-based interventions and testing environment suggests that “children are more likely to perform better in the home environment” (Garwood and Fewell, 1983). Park, Fisher and Velozo (1994) show that adults score higher on a process skill measure when tested in a familiar environment. Ainsworth and Bell (1970) describe children’s decreased exploratory behavior in novel environments with strangers present.

Clearly, the available literature is not sufficient to definitively answer our research question. Therefore, in the following sections of our thesis, we develop and describe the methods used to determine the effects of an unfamiliar testing environment on the GMFM scores of 18-37 month old children.
CHAPTER 3
METHODOLOGY

Research Design

We designed our study to fit a repeated measure counterbalanced design so that we could compare the effects of a familiar versus an unfamiliar environment on GMFM scores. This design allowed us to determine the effects of test environment sequence on GMFM scores. We counterbalanced testing conditions so that the order of testing environments is varied and a stranger will always test the child. Using a counterbalance group assignment, we created a crossover design within four subject groups:

1a) First test was administered by student A in a familiar setting
1b) Second test was administered by student B in an unfamiliar setting
2a) First test was administered by student B in a familiar setting
2b) Second test was administered by student A in an unfamiliar setting
3a) First test was administered by student A in an unfamiliar setting
3b) Second test was administered by student B in a familiar setting
4a) First test was administered by student B in an unfamiliar setting
4b) Second test will be administered by student A in a familiar setting

We randomly assigned subjects to one of the four groups. During test set-up the caregiver completed a modified Connor's Parent Rating Scale. We then administered the GMFM. The independent variables in this design are the test environment (familiar and unfamiliar) and the order of testing. The dependent variable is the score on the GMFM.
This study does not fit the criterion for a true experiment and is a quasi-experiment. In this study we chose a sample of convenience, not a random selection of subjects. "Even though quasi-experimental designs cannot rule out threats of internal validity with the same confidence as experimental designs, quasi-experimental designs are considered appropriate when stronger designs are not feasible" (Portney & Watkins, 1993). Using this design, subject attrition will be a threat to internal validity that is difficult to control. Researchers define attrition as "the differential loss of participants during the course of data collection, potentially introducing bias by changing the composition of the sample" (Portney & Watkins, 1993). In our research the quasi-experimental design is used because completely random selection of subjects is impossible; we only selected from those individuals we recruited and whose parents allowed them to participate.

Subjects

Our subjects in this study included 16 developmentally normal children between the ages of 18 and 37 months. Subject age range was based on two previous studies. Suffridge, Hart, Huchingson, & Clark (1997) used this age range in a similar study to ours. Also, the study by Russell et al. (1989) showed significant data that younger children (<36 months old) show greater change in GMFM scores compared to older children (>36 months). There were 10 girls and 6 boys in our study. 12 of the 16 children were the children of physical therapists. There was one set of twins and one brother and sister pair in our study. We recruited these subjects through caregivers with
children of the appropriate age. We obtained caregiver consent in writing for each child participating in the study (Appendix A). Those children who met our inclusion criteria were accepted for this study. We provide lists of these criteria in Appendix B.

Portney and Watkins (1993) note that one limitation of convenience sampling is the bias present in self-selection. This means that caregivers who volunteer and their children may differ from the target population, in motor function and in other areas (Portney & Watkins, 1993). Portney and Watkins further state that this bias prevents the researcher from estimating sampling error. This inability to estimate sampling error limits the researcher's ability to generalize outcomes beyond the specific sample studied and therefore, research outcomes must be interpreted with caution (Portney and Watkins, 1993). We controlled some effects of a self-selection bias by randomizing our assignment of subjects into four experimental groups. Each student researcher tested every child. This method was used to maintain a constant stranger anxiety level in the subjects. Also, each investigator tested an equal number of subjects in home and unfamiliar environment to avoid investigator proficiency in a certain environment.

Researchers determined subject group assignment through the use of a lottery system. Each subject's name was written on a piece of paper and placed in a hat. An individual blind to our study drew names from the hat. Subjects were assigned to a pre-determined list in the order that the subject's names were drawn.

**Study Site**

Our preferred familiar testing site was the child's home. Caregivers chose the
child's daycare site when the home site was unavailable. The unfamiliar testing site was one the child had never visited. These sites included Grand Valley State University's therapeutic exercise room in the physical therapy department, parent's work place, and investigator's homes.

**Materials**

**GMFM**

We use the GMFM to determine each child's level of motor function using pre-selected items from this measure. (Appendix E) We asked children to complete the following items: lying and rolling items 8,9,14,15, sitting items 28, 29 and 33-37, crawling and kneeling items 45-51, standing items 52-64 and walking running and jumping items 69-88. We based the selection of the items on the emergence of gross motor skills normal to typical 17 to 37 month old children. We scored these items following the GMFM 4-point Likert scale. We automatically scored a zero to questions that were developmentally simple for our subjects. This shortened test time allowed researchers and subjects to focus on developmentally appropriate or slightly challenging questions. Russell and colleagues (1993) write about responsiveness and have stated that “inclusion of items which are not responsive to change will only detract or add noise to the measure.” This statement as applied to our specific study suggests that simple test items (items accomplished at an earlier age) may be scored a zero. For example, GMFM question # 24 requires that a child maintain a sitting position, arms free, for 3 seconds. This simple motor function has already emerged in 17 – 37 month old children (Long &
Cintas, 1995) and therefore will be scored a zero. The benefits of following these guidelines include optimal responsiveness to questions that are developmentally appropriate or slightly challenging. Also, by eliminating questions that would be simple for subjects to complete, we shortened test administration time. The shorter test time allowed subjects to finish testing with less fatigue and better ability to concentrate on skills we asked them to complete.

Abbreviated Connors' Parent Rating Scale

We administered this behavior scale to caregivers during the set-up for the GMFM. (Appendix C) The Connors' Parent Rating Scale, Form 93, was abbreviated to include questions for caregivers to answer that indicated behaviors of anxiousness or shyness. Items were scored with the resulting data analyzed using the Pearson Correlation Coefficient (r) and displayed in a table format. Significance of the correlation was determined by a probability value (p). Student investigators used this quantitative information to determine if a relationship existed between GMFM scores and CPRS scores.

Reliability

We established reliability in a three-phase process. In phase one, student-testers gained a working understanding of the GMFM. Dr. Peck (an experienced pediatric physical therapist trained to administer the GMFM) trained student-testers to administer the GMFM. In phase two, student investigators practiced scoring five videotaped children two times with a two-week interval. Intra-rater reliability was
established by comparing student tester's first and second scores. Comparison of test scores between student testers and Dr. Peck was done to establish inter-rater reliability. Finally, we conducted a pilot study. Dr. Peck and student investigators jointly administered the GMFM to three children and individually scored this measure. In this final phase we established comfort and inter-rater reliability with real children. We used the Intra Class Correlation Coefficient to determine reliability values with r=0.90 as the acceptance level.

**Procedure**

We tested children according to GMFM guidelines. Following study procedures, we divided the 16 subjects into four groups. During set-up of the first testing experience for the subject, their caregiver completed the modified infant behavior inventory. The second testing was completed fourteen to twenty-one days after the first test application.

**Data Analysis**

Data analysis was conducted on the Statistical Analysis System (SAS) computer system. Analysis of variance was used to analyze GMFM data. Pearson Correlation Coefficients were used to relate Connors' Parent Rating score to GMFM scores. Interclass Correlation Coefficients were utilized when determining intra- and inter-rater reliability.
CHAPTER 4
RESULTS

Data Analysis

The specific method utilized to analyze GMFM raw scores was the ANOVA analysis of variance using a counterbalanced design. Data are supplied for sum of squares, degrees of freedom, mean square, F-ratio, and probability values (Table 1). The primary factor examined was the effect of environment on test scores, although we considered the three factors of environment, subject, and sequence to identify their effects.

Results

Results for GMFM scores are based on a total of thirty-two numbers; two test scores for each of the 16 subjects. Statistical analysis is listed in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of freedom</th>
<th>Mean Square</th>
<th>F-Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>1981.35</td>
<td>17</td>
<td>116.55</td>
<td>5.94</td>
<td>0.0008</td>
</tr>
<tr>
<td>Environment</td>
<td>4.73</td>
<td>1</td>
<td>4.73</td>
<td>0.24</td>
<td>0.6310</td>
</tr>
<tr>
<td>Subject</td>
<td>1913.06</td>
<td>15</td>
<td>127.54</td>
<td>6.50</td>
<td>0.0006</td>
</tr>
<tr>
<td>Sequence</td>
<td>63.56</td>
<td>1</td>
<td>63.56</td>
<td>3.24</td>
<td>0.0934</td>
</tr>
<tr>
<td>Within subjects</td>
<td>274.52</td>
<td>14</td>
<td>19.61</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>Total</td>
<td>2255.87</td>
<td>31</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
</tr>
</tbody>
</table>
Hypothesis

The null hypothesis that the familiarity of the environment to the child would not effect their GMFM scores was not rejected. We did not reject our null hypothesis based the 0.6310 probability value for environment.

Findings of Interest

The probability value for sequence (the difference in score between first and second test) was not statistically significant with a p value of 0.0934. However, because our sample size was small we feel this value indicated that there was a difference in performance from first to second test. Children in our study tended to perform better on the second test. This result is further discussed in Chapter 5.

Connors' Parent Rating Scale results

Correlation results for the Connors' Parent Rating Scale scores and the difference between GMFM test 1 and GMFM test 2 follow in Table 2. Connors’ Parent Rating Scale results, when correlated to the difference between GMFM results in the familiar environment and unfamiliar environment, showed no significant correlation. The degrees of freedom calculation for this measure was 14(n-2) where n=16. R=.1989 and P=.460.
Correlation results showed that shy/anxious behaviors of the subjects appeared not to be a significant factor when correlated with the difference between GMFM test results.

**Inter-rater and Inter-rater Reliability**

Reliability for administering the GMFM test was established through the Intraclass Correlation Coefficient (ICC). Inter-rater results were 0.99. Intra-rater results for researcher A was 0.99 with researcher B having 0.97.

<table>
<thead>
<tr>
<th>Source</th>
<th>R</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference between GMFM test 2 and GMFM test 1 and correlation to CPRS</td>
<td>R=.1989</td>
<td>P=.460</td>
</tr>
</tbody>
</table>
Discussion of Findings

Our purpose in research was to compare GMFM test scores in familiar and unfamiliar environments in children 17-37 months old. No support was found for the alternative hypothesis that the child’s score on the GMFM in the familiar environment would not equal that of the score in the unfamiliar environment. This finding is somewhat surprising in light of Ainsworth and Bell’s 1969 research, Weir and May’s 1988 research, and Park, Fischer and Velozo’s 1993 research described in our literature review. The researchers listed above studied infant exploration and attachment behavior, college test results, and adult processing skills respectively. Research findings suggest novelty of environment did result in inferior test performances in the subjects tested.

One possible explanation for our subjects’ consistency in score between familiar and unfamiliar environments was the presence of the child’s caregiver in both testing environments. Ainsworth and Bell found that presence of the child’s mother in a strange environment encouraged the child to explore while her absence decreased exploration and heightened attachment behavior (Ainsworth and Bell, 1970). Belkin and Routh supported these results in 3-year-old children in their 1975 study. Our subjects may have performed similarly in familiar and unfamiliar testing environments because their caregiver was present.
Ancillary factors were considered in analysis and are described in the following paragraphs. Student researchers examined the difference in score on the GMFM between first and second testing experience and, although the results were not statistically significant, found that children tended to perform better on the second test. Since our sample size was small, a p-value of 0.09 warrants consideration. This 0.09 p-value may have indicated that a change occurred between the first and second testing experience. This improved performance of our subjects during their second test could have been due to multiple factors. One factor that we explored in our literature review was the learning effect. Andrew Meltzoff's 1988 research showed that infants who simply observed objects being manipulated without an opportunity to practice showed learning effects. Another explanation for higher scores on the second testing experience could have been the result of real developmental changes in children over the two-week period between tests. Without further research these explanations are speculative.

A second factor we considered was the role our subject's anxious-shy behavior in their performance on first and second GMFM testing experiences. Higher scores on the Connors' Parent Rating Scale (CPRS) indicated higher levels of anxious/shy behaviors. Originally, we thought that children with high CPRS scores would have performed differently between the first and second testing experiences than children with lower CPRS scores. A low correlation value between anxious/shy scores and GMFM scores suggest this difference did not occur.

Factors that we attempted to control included influence of caregiver, learning
effects, and stranger anxiety. During testing we required the presence of a caregiver because psychology literature suggests that absence of the caregiver heightens attachment behavior and may decrease a child’s ability to attend to testing experiences. (Ainsworth, 1969) We chose a counter balanced design to control for the bias of learning effects from test experience number one to test experience number two. Data analysis suggested that children in our study tended to perform better on test number two; our study design did not allow us to control for this subtle effect. We used a random placement of subjects on a testing schedule in which first test experience was divided evenly between sites familiar and unfamiliar to the subjects. This prevented skewed test results based on learning effects. Also, as part of our counterbalanced design, first and second tests were always administered by a tester the child not know to maintain the stranger effect. Interestingly, in an unpublished study similar to ours entitled Comparison of the Reliability of the Gross Motor Function Measure in Two Environments: Familiar and Unfamiliar, investigators did not use a counterbalanced design and found results similar to ours. In the above study, the same individual tested subjects during both first and second testing experiences (Suffridge et al., 1997).

Personal observations that we made while conducting this research included variation in the physical testing environment and the effects of this variation on children. For example the steps at Henry Hall at GVSU are wide and rubber coated while, the steps in many children’s homes were narrow and carpeted. Children appeared more comfortable on carpeted narrow steps. This observation was substantiated by parent
report. Finally, many subjects had siblings present during testing. In observation, siblings enhanced and/or distracted form subject’s ability to focus on test questions depending on the individual situation. For example, some subjects tended to mimic older siblings. At other times, the sibling would distract the child by engaging them in non-test activities.

**Implications for Practice**

Currently, therapists use the GMFM to evaluate gross motor skills of children with cerebral palsy. Therapists administer this measure in a variety of settings. Our results suggested that the GMFM was reliable across familiar and unfamiliar environments for our subjects. For example, a therapist may perform an initial GMFM evaluation in a clinical setting, perform the final GMFM evaluation in the child’s home, and be confident that the location of the test did not effect the results. This finding was encouraging considering the practical and financial burdens that the opposite finding would place on the healthcare system. For example, testing and re-testing children in the same treatment room both times may limit the therapist’s flexibility in the clinic and may not be workable. Historically, the GMFM had been administered in the home and in the clinic. Had choice of environment decreased the reliability of this test, children who performed poorly in clinic and qualified for services may have performed well at home and hence, not qualified for services. Our research indicated that the environment is not a statistically significant variable for our subjects. Therefore, the therapist may use results
from both environments to make a meaningful assessment of the child’s response to therapeutic intervention.

**Limitations**

A number of factors must be considered with interpretation of data results. First, the sample size was limited in number of subjects and was chosen based on a sample of convenience. Subjects consisted of normal children. Thus, results of this study cannot be applied to children with the diagnosis of cerebral palsy, the target population for GMFM development. Our research cannot be applied to the overall child population, only to developmentally normal children 17 – 37 months old.

A child’s personality could have affected their mood at the time of testing or their rapport with the tester. Also, a child’s previous experience in performing the gross motor skills required by the GMFM had a greater effect than the environment could have. For example, a child involved in gymnastics or another sport may perform better on the GMFM than a child who does not participate in these activities. Although we had no way to control for these factors in our study, we hoped to minimize these effects by randomly distributing children into our testing schedule.

One tester may have established a better rapport with an individual child than another tester during test administration. This may have effected the quality of the relationship between tester and child, thus may have effected the child’s GMFM score. For example, a child may want to please a tester that he or she likes and ignore a tester that he or she does not like. This may have resulted in a child refusing to perform a skill
even though they might be physically able to perform the gross motor skill. This limitation was impossible to control for in our study. Interestingly, in a study similar to ours by Suffridge et. al (1997), student researchers had similar results and had the same tester administering the GMFM to children in both familiar and unfamiliar environments. This suggests that this limitation had minimal effect on our subject’s GMFM scores.

Researchers attempted to control unfamiliar environment and inter-tester reliability. Unfamiliar environment was defined as a place a child had never been before. However in our experiment the unfamiliar environment was not consistent. Unfamiliar environments included Grand Valley State University classrooms, caregiver work sites, and investigator’s homes. Effects of different unfamiliar environments cannot be accounted for.

Also, inter-tester reliability was established using five videotaped children. This allowed testers to become familiar with and practice scoring GMFM test questions. This way, researchers could focus on scoring the specific test questions without having to administer the test to a child. Additionally, test scores could be rated knowing each tester saw the same motor response. A weakness of this method was the lack of interaction with a child. We addressed this lack of interaction with children by personally testing and scoring three live children. In future studies we recommend testers use both video taped and live children to establish inter and intra rater reliability.

The length of time spent with each child was not standardized. The amount of time spent with each child may have influenced test score. For example, the tester may
become more familiar to the child and performance may have improved. If one tester spent two hours with a child and another tester only spent one hour with the same child, the child with the two-hour time block had greater opportunity to demonstrate skills. Two sets of two children were tested simultaneously due to parental time constraints. All other children were tested individually. Based on these limitations of our research we will discuss modification of these limitations in the following section.

**Recommendations for Further Research**

Additional research is warranted to discover the role of the presence of the subject's caregiver on GMFM scores across environments. Ainsworth and Bell report that children show distress, less exploratory behavior, and increased attachment behavior (behaviors promoting contact such as crying, clinging, approaching, following, smiling, and calling) in the absence of the caregiver. The literature showed these behaviors were also true in the presence of strangers in a novel environment.

Another relatively unexplored area in physical therapy is the role of learning effects in children between first and second testing experience. Subjects with multiple experiences taking the GMFM may show learning effects rather than true motor function change. Multiple experience may threaten the validity of test results.

Additionally, an improved version of our study may provide more meaningful results. Improvements on our current research could include a sample that was not biased. Incorporating a large sample size chosen through random selection decreases bias. Another area of potential bias was in our observation. In the dual roles of
investigator and author, our expectations could have consciously or unconsciously influenced results. Blinding can remove observer bias (Portney & Watkins, 1993). Furthermore, therapists use the GMFM to measure the gross motor function of children with cerebral palsy. Researchers cannot unilaterally generalize our results to children with cerebral palsy because our research subjects were developmentally normal. To control for the amount of the time spent with each child, scores may be taken at set times to determine if score increases as children become more familiar with the tester or with longer or shorter testing experiences.

In summary, we recommend that future studies incorporate a larger, randomly selected sample size of children diagnosed with cerebral palsy with GMFM test scores calculated 45 minutes into the testing experience, and each additional 15 minutes required to test the children.

Conclusion

Familiarity of environment to 17-37 month old subjects did not influence GMFM test scores in the children we studied. However, GMFM score on the second testing experience, while not statistically significant, tended to be higher for these same subjects. We recommend that future researchers study the effects of environment, presence of caregiver and learning effects on GMFM results. Researched-based information on factors that potentially influence the reliability and validity of test results can guide the therapist in clinical decision making.
REFERENCES


APPENDIX A

GRAND VALLEY STATE UNIVERSITY RESEARCH CONSENT FORM

Title of Project: The Effect of Familiar and Novel Testing Environments on the Gross Motor Function Measure Score of Developmentally Normal Children 17-37 Months Old

Principle Investigators: Jean Angel and Tracey Blain

PURPOSE OF RESEARCH:
The purpose of this study is to compare test results on the Gross Motor Function Measure (GMFM) of developmentally normal children between the ages of 17-37 months. The Gross Motor Function Measure will be given once in an environment that is familiar to your child, such as his/her home, and a second time in a setting that is unfamiliar to your child, such as a clinic examination room. Test results will then be compared to see whether a child’s motor abilities can accurately be assessed in an unfamiliar testing environment. Accurate assessment measures lead to optimally efficient treatment sessions. Our research will give physical therapists information about the best location for assessing the motor skills of young children.

PROCEDURE
My child and I will be expected to participate in two physical therapy assessment sessions. I am aware that the procedures include the completion of a modified Connor’s Parent Rating Scale filled out by me during my child’s participation in GMFM testing. Assessment will be limited to 60 minutes on each of the two test days.

CONFIDENTIALITY
I understand that the information obtained from this study will be confidential and used only for research. My child’s data results will be stored in the investigators research file and identified by a code number. If the data is used for publication or teaching purposes, no names will be used.

RISKS AND BENEFITS
Risks to child participants in the study are minimal. The procedures are non-invasive and assess the simple gross motor tasks of 1) lying and rolling, 2) sitting, 3) crawling and kneeling, 4) standing, 5) walking, running and jumping. The child may find working with the project evaluators mildly distressing and/or interrupting to his or her usual routines.

Conversely the child may benefit from the opportunity of working with unfamiliar adults in an assessment protocol. Performing familiar tasks for a friendly new adult may be enjoyable to your child and allow practice for him/her to cooperate in a medical
evaluation. Potentially this study could benefit physical therapists and their young patients by providing information that will better ensure accurate motor skill evaluation and effective treatment.

REQUEST FOR INFORMATION
I understand that I may ask more questions about the study at any time. Jean Angel (616) 363-2849, Tracey Blain (616) 458-8251, and John Peck, PT, PhD (616) 895-3356 are available to answer my questions or concerns.

If during the study, or later, I wish to discuss my child's participation in or concerns regarding this study with a person not directly involved in the study, I am aware that Paul Huizenga of the Human Subjects Review Committee GVSU (616) 895-2472 is available to talk with me.

REFUSAL OR WITHDRAWAL OF PARTICIPATION
I understand that my child's participation is voluntary and that he/she may refuse to participate or may withdraw consent and discontinue participation in this study at any time. I also understand that Jean Angel or Tracey Blain may terminate my child's participation in this study if my child does not meet inclusion criteria. I will be notified immediately to avoid any confusion or unnecessary time requirements.

INJURY STATEMENT
I understand that by my agreement for my child to participate in this study, I am not waiving any of my legal rights. Emotional or physical risk to the child is not expected in performing this research.

I have explained to ______________________ the purpose of the research and the procedures required to the best of my ability.

_________________________________  __________________________
Investigator  Date

I confirm that Jean Angel and Tracey Blain have explained to me the purpose of the research, the study procedures that my child and I will undergo. Therefore, I agree to give my consent for my child to participate as a subject in this research project.

_________________________________  __________________________
Parent/Legal Guardian  Date

_________________________________  __________________________
Witness to Signature  Date
APPENDIX B

PARTICIPANT QUESTIONNAIRE INCLUSION CRITERIA

Child’s Name: ________________________________________________

Parent/Legal Guardian’s Name: __________________________________

Child’s Birthdate: __________ Gender: _____ Phone: ______________

Date Today: __________

Has your child ever required medical attention for any of the following conditions? These conditions may effect the results of the GMFM test.

Heart Conditions Y / N
Dizziness/Fainting Y / N
Hypertension Y / N
Seizures Y / N
Head Injuries Y / N
Hypoglycemia Y / N
Hearing Problems Y / N
Visual Problems Y / N
Balance Problems Y / N
Developmental Delays Y / N
Has your child had surgery before? Y / N
Does your child have orthopedic problems? Y / N
Is your child currently taking Medication? Y / N
Other Conditions: ____________________________________________

____________________________________________________________
APPENDIX C

ABBREVIATED CONNOR'S PARENT RATING SCALE

CHILD NAME: ________________________________

CHILD AGE: ________________________________

CHILD GENDER: Male _________ Female __________

PARENT/ CAREGIVER: __________________________

Instructions: Read each item below carefully, and decide how much you think your child has been bothered by this problem during the past month. Circle only one number please.

Key: 1 = Not at All
     2 = Just a Little
     3 = Pretty Much
     4 = Very Much

1 2 3 4 Afraid of new situations.
1 2 3 4 Afraid of people.
1 2 3 4 Afraid of being alone.
1 2 3 4 Cries easily.
1 2 3 4 Clings to parents or other adults.
1 2 3 4 Shy.
1 2 3 4 Afraid friends do not like him/her.
1 2 3 4 Feelings hurt easily.
1 2 3 4 Feels cheated.
APPENDIX D

INFORMATION SHEET FOR PARENTS/GUARDIANS AND PARTICIPANTS

The purpose of this study is to compare the test results of the Gross Motor Function Measure (GMFM) in children between the ages of 17-37 months. Therapists frequently perform the GMFM in an environment unfamiliar to the child that they are testing, such as a clinical examination room. Our research will determine the degree to which the child’s motor function in unfamiliar testing environments can be assessed accurately. Because valid test information leads to efficient treatment, our research will potentially improve the treatment of children requiring physical therapy evaluation and/or service.

The GMFM tests children’s motor functional ability in five positions/activities which include: 1) lying and rolling, 2) sitting, 3) crawling and kneeling, 4) standing, and 5) walking, running, and jumping. These activities are similar in intensity to an active day of play and are designed to be fun for children.

We will do our best to insure a safe and enjoyable experience for your child. In addition, we will work to maintain the complete confidentiality for all subjects. We will encode all names and records of participants.

Jean Angel and Tracey Blain, Grand Valley State University (GVSU) graduate students in physical therapy, are conducting this study. Dr. John Peck, the GVSU Physical Therapy Program Director, Barb Baker, GVSU Professor in Physical Therapy, and Neal Rogness, GVSU Statistics Professor form our research committee.
The chairperson of the thesis committee is Dr. John Peck. Both Dr. Peck and Barb Baker are physical therapists with experience in the evaluation and treatment of children.

The Human Subjects Committee reviews all research with human subjects. The committee has strict criteria for safety and ethics. The chairman of the Human subjects committee is Paul Huizenga. Contact Paul Huizenga (616) 895-2472 and Dr. John Peck (616) 895-3356 with questions or concerns regarding your child’s participation in the study.

Thank you for your time in reviewing this information. We hope improve in the evaluation and treatment of children by providing quantitative data on the GMFM test.

Jean Angel SPT

Tracey Blain SPT
Child's Name: ___________________________________________ I.D. #:________________________

Date of Birth (yr/mth/day): __________________ Assessment Date (yr/mth/day): ________________

Diagnosis: __________________________

Evaluator’s name: ________________________________________________________________

Testing Conditions (e.g. room, clothing, time, others present)
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

The GMFM is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with cerebral palsy.

*SCORING KEY 0 = does not initiate
1 = initiates
2 = partially completes
3 = completes

*Unless otherwise specified, "initiates" is defined as completion of less than 10% of the item. "Partially completes" is defined as completion of 10% to less than 100%.

The scoring key is meant to be a general guideline. However, most of the items have specific descriptors for each score. It is imperative that the guidelines be used for scoring each item.
Check ( ) the appropriate score:

<table>
<thead>
<tr>
<th>Item A: LYING AND ROLLING</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROLLS TO PR OVER R SIDE</td>
<td>0 □  □  □  3 □</td>
</tr>
<tr>
<td>ROLLS TO L</td>
<td>0 □  □  □  3 □</td>
</tr>
<tr>
<td>ROLLS TO R SUPINE OVER L SIDE</td>
<td>0 □  □  □  3 □</td>
</tr>
<tr>
<td>TOTAL DIMENSION A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item B: SITTING</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R SIDE SIT: MAINTAINS ARMS FREE, 5 SEC.</td>
<td>(28) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>SITTING: PIVOTS 90°, Without ARMS ASSISTING.</td>
<td>(29) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>SIT ON BENCH: MAINTAINS, ARMS AND FEET FREE, 10 SECONDS.</td>
<td>(33) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>STD: ATTAINS SIT ON SM. BENCH.</td>
<td>(35) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>ON THE FLOOR: ATTAINS SIT ON SM. BENCH.</td>
<td>(36) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>ATTAINS SIT ON LG. BENCH.</td>
<td>(37) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>TOTAL DIMENSION B</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item C: CRAWLING AND KNEELING</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRAWLS RECIPROCALLY FORWARD 6'</td>
<td>(45) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>CRAWLS UP 4 STEPS ON HANDS &amp; KNEES or FEET</td>
<td>(46) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>CRAWLS BACKWARDS DOWN 4 STEPS ON HANDS &amp; KNEES or FEET</td>
<td>(47) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>SIT ON MAT: ATTAINS HIGH KN USING ARMS, MAINTAINS, ARMS FREE, 10 sec.</td>
<td>(48) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>HIGH KN: ATTAINS HALF KN ON R KNEE USING ARMS, MAINTAINS, ARMS FREE, 10 sec.</td>
<td>(49) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>KN WALKS FORWARD 10 STEPS, ARMS FREE</td>
<td>(51) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>TOTAL DIMENSION C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item D: STANDING</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON THE FLOOR: PULLS TO STD AT LG. BENCH.</td>
<td>(52) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>STD: MAINTAINS, ARMS FREE, 3 sec.</td>
<td>(53) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>HOLDING INTO LG. BENCH WITH ONE HAND, LIFTS R FOOT. 3 sec.</td>
<td>(54) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>MAINTAINS, ARMS FREE, 20 sec.</td>
<td>(55) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>LIFTS L FOOT, ARMS FREE, 10 sec.</td>
<td>(57) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>LIFTS L FOOT, ARMS FREE, 3 sec.</td>
<td>(58) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>SIT ON SMALL BENCH: ATTAINS STD WITHOUT USING ARMS.</td>
<td>(59) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>HIGH KN: ATTAINS STD THRU HALF KN ON R, WITHOUT USING ARMS</td>
<td>(60) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>LOWERS TO SIT ON FLOOR WITH CONTROL, ARMS FREE.</td>
<td>(62) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>ATTAINS SQUAT, ARMS FREE.</td>
<td>(63) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>PICKS UP OBJECT FROM FLOOR, ARMS FREE. RETURNS TO STD.</td>
<td>(64) 0 □  □  □  3 □</td>
</tr>
<tr>
<td>TOTAL DIMENSION D</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>WALKING, RUNNING AND JUMPING</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS FORWARD 10 STEPS</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS FORWARD 10 STEPS, STOPS, TURNS 180°, RETURNS</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS BACKWARD 10 STEPS</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS FORWARD 10 STEPS, CARRYING A LARGE OBJECT WITH 2 HANDS</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS FORWARD 10 CONSECUTIVE STEPS BETWEEN PARALLEL LINES 8&quot; APART</td>
</tr>
<tr>
<td>↓</td>
<td>STEPS OVER STICK AT KNEE LEVEL, R FOOT LEADING</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS BACKWARD 10 STEPS</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS FORWARD 10 CONSECUTIVE STEPS ON A STRAIGHT LINE ½&quot; WIDE</td>
</tr>
<tr>
<td>↓</td>
<td>STEPS OVER STICK AT KNEE LEVEL, L FOOT LEADING</td>
</tr>
<tr>
<td>↓</td>
<td>RUNS 15 FEET, STOPS &amp; RETURNS</td>
</tr>
<tr>
<td>↓</td>
<td>KICKS BALL WITH R FOOT</td>
</tr>
<tr>
<td>↓</td>
<td>STEPS OVER STICK AT KNEE LEVEL, L FOOT LEADING</td>
</tr>
<tr>
<td>↓</td>
<td>JUMPS 12&quot; HIGH, BOTH FEET SIMULTANEOUSLY</td>
</tr>
<tr>
<td>↓</td>
<td>JUMPS 12&quot; FORWARD, L FOOT</td>
</tr>
<tr>
<td>↓</td>
<td>STANDARD ON R FOOT: HOPS ON R FOOT 10 TIMES WITHIN A 24&quot; CIRCLE</td>
</tr>
<tr>
<td>↓</td>
<td>STANDARD, HOLDING 1 RAIL: WALKS UP 4 STEPS, HOLDING 1 RAIL, ALTERNATING FEET</td>
</tr>
<tr>
<td>↓</td>
<td>STANDARD, HOLDING 1 RAIL: WALKS DOWN 4 STEPS</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS UP 4 STEPS, ALTERNATING FEET</td>
</tr>
<tr>
<td>↓</td>
<td>WALKS DOWN 4 STEPS</td>
</tr>
<tr>
<td>↓</td>
<td>STANDARD ON 6&quot; STEP: JUMPS OFF, BOTH FEET SIMULTANEOUSLY</td>
</tr>
</tbody>
</table>

**TOTAL DIMENSION E**

Was this assessment indicative of this child’s “regular” performance? **YES □ NO □**

**COMMENTS:**

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APPENDIX F

EMERGENCE OF MOTOR BEHAVIORS 1 - 5 YEAR OLD
(Long & Cintas, 1995)

1 year old → Transitions from prone to standing through ½ kneel; knee release to support smooth descent from standing.

13 - 14 months old → Sustained standing without external support; stoops to pick up object and regains standing.

15 - 16 months old → Arm position while walking is low-guard; creeps up steps or walks up with external support.

17 - 18 months old → Carries or pulls an object while walking; creeps down steps; steps on ball positioned for kicking; tries steps using rail.

20 - 22 months old → Walks up steps with step-to pattern and external one-hand support; easily stoops and recovers.

2 years old → Kicks ball forward; throws ball overhand for 5 feet; jumps off low step; 2-foot jump from floor emerging.

30 months old → Jumps off step with 1 foot leading, 2 feet emerging; jumps off floor with 2 feet; can imitate walking on tiptoes; mounts tricycle.

3 years old → Jumps off step to land with 2 feet; easily propels riding vehicle with feet on floor, may be pedaling; stands on 1 foot briefly.

42 months old → Mounts, pedals and dismounts several types of three-wheel riding vehicles; stands on 1 for > 3 seconds, begins hopping on 1 foot.

4 years old → Rotation of body following forward projection of ball; several hops in succession on 1 foot; stands and walks on tiptoes if so inclined.

54 months old → Catches ball by fluid accommodation of arm as ball approaches, elbows may be at sides; throws ball to another person 8 - 10 feet away; jumps 2 -3" off floor.

5 years old → Jumps forward and sideways with two-foot takeoff, two-foot landing emerging; jumps over 6 - 8" from floor; throws ball to hit target at 10 feet.