

Protocol Summary form for Department of Education Grant

Title: Efficacy of the START-Play Program for Infants with Neuromotor Disorders

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1. Statement of the research question

This large 4-year multi-site study aims to determine the efficacy of a specific program of intervention for infants with neuromotor disorders such as cerebral palsy. The project is funded by the National Center for Special Education Research within the US Dept. of Education, with Duquesne University as the lead site. The overall purpose of this project is to evaluate the efficacy of a fully developed intervention designed to target sitting, reaching and motor-based active problem solving in infancy to improve global developmental outcomes and readiness to learn prior to preschool for children with neuromotor dysfunction. The following are our primary and secondary hypotheses.

PRIMARY HYPOTHESES

Hypothesis 1: Compared to a control group receiving standard of care services, the START-Play group will show greater improvements from pre- to post- intervention (short-term effect) in:

- a. sitting Variable: Gross Motor Function Measure (GMFM) sitting scores
- b. reaching Variable: Number of toy contacts
- c. problem-solving Variable: Individual Growth and Development Indicator(IGDI) problem-solving score
- d. global development Variable: Bayley III score

Hypothesis 2: Compared to the control group, the START-Play group will show greater sustained improvements from pre-intervention to one year since start of intervention (long-term effect) in:

- a. sitting Variable: GMFM sitting scores
- b. reaching Variable: Number of toy contacts
- c. problem-solving Variable: IGDI problem-solving score
- d. global development Variable: Bayley III score

Hypothesis 3 (Mediation): Improvements in global development will be (at least) partially mediated by improvements in problem-solving as a function of the intervention at the end of the project (long-term proximal effect).

Variables: GMFM scores, toy contacts, IGDI problem-solving and Bayley III scores.

SECONDARY HYPOTHESES

Analysis of moderators

1. *Hypothesis:* Severity of motor impairment will have a significant influence on overall change in IGDI problem-solving, and motor scores, as well as Bayley III scores. Variable: Severity score
2. *Hypothesis:* Factors external to the child (socialization opportunities [Modified Parent Child Interaction-Dyadic Mini Code scores (Censullo, 1991) (PCI-DMC)], and home environment (HOME Inventory [Bradley, 1993] & SocioEconomic Status [SES]), will have a moderate effect on change in GMFM, problem-solving, and Bayley III scores.

Further analysis of motor variables

3. *Hypothesis:* The START-Play group will show posture control *short-term postural control changes* that are closer to normative values than the control group from pre to post intervention (*3 months post baseline*). This hypothesis tests additional variables quantifying sitting to supplement Primary Hypothesis 1. Variables: Kinematic measures taken from video analysis.

4. *Hypothesis:* Compared to the control group, the START-Play Intervention group will show greater *short-term* improvements in duration of toy contact and object manipulation from pre to post intervention (*3 months post baseline*). This hypothesis tests additional variables quantifying reaching to supplement the Primary Hypothesis 2. Variables: Unilateral and bilateral contact number and duration, and type of contact (i.e. hand open or closed; palmar or dorsal hand surface, manipulation variables).

2. Purpose and significance of the study

Infants use two fundamental motor skills, sitting and reaching, for orientation and selection of important environmental information. Emerging during development at around 6 months of age, these motor skills form the core abilities to explore the environment and propel further learning and development (Soska et al, 2010; Rochat 1992; Adolph & Berger 2011). Not surprisingly, children with delays in these skills experience a cascade of motor, cognitive and social impairments. These impairments seriously impede readiness to learn at pre-school and subsequently school age (van der Heide et al, 2004; Ricken et al, 2005). For children with neuromotor dysfunction, we define “**readiness to learn**” as a level of development at which the child can orient and attend to information in the world, actively engage with materials and people, begin to solve problems, and perform developmentally appropriate tasks.

Although early intervention services are well established throughout the United States, the evidence that these services make a difference in developmental or educational outcomes for infants with neuromotor dysfunction is limited (Spittle et al, 2007). *Early intervention is a federally mandated system of services (Individuals with Disabilities Education Act, Part C, 2004) to advance developmental outcomes in infants and toddlers who have developmental delays or disabilities. Motor intervention for children with neuromotor disorders (e.g., cerebral palsy) consists of developmentally appropriate movement activities prescribed by a physical therapist, with the goal of advancing movement skills such as sitting, crawling, walking or moving with assistive devices (e.g., walker, wheelchair).* A recent review of randomized trials of early intervention for preterm infants found that, although there were significant short-term advances in cognitive outcomes during infancy, motor skills were not affected by early intervention, and short-term effects on cognitive outcome were not sustained at school age (Orton et al, 2009). No studies have specifically examined infants with neuromotor dysfunction. In addition, early motor intervention historically has been passive, and has not been linked to learning (Rapport et al, 2004; Dunst & Trivette, 2008). Consequently, there is a knowledge gap about which specific interventions produce positive motor outcomes that are related to global development and problem solving. The START-Play intervention targets the primary skills of sitting and reaching at a critical point when infants need to learn these skills in order to advance understanding of the world. For most infants with neuromotor disorders sitting and reaching do not emerge on time, which begins a cycle of lost learning opportunities, ultimately resulting in the significant lack of readiness to learn often noted in preschool. Early in infancy, delays in sitting and reaching reduce the likelihood that an infant builds understanding of spatial concepts (Soska et al, 2010), social relationships (Palisano et al, 2009), problem-solving (Fennell & Dikel, 2001), and play skills (Brown & Gordon, 1987) that scaffold global development and result in educationally relevant outcomes. This proposal is the first comprehensive research plan to build these key skills early enough to enhance early learning capacity for children with neuromotor disorders. Thus, our overall purpose is to test the efficacy of a motor intervention for infants with neuromotor disorders compared to early intervention services provided as usual care.

3. Research design and procedures

The study design enrolls infants with neuromotor disorders or identified delays in a 3-month randomized controlled trial with a repeated measures design plus a nine-month follow-up. The design is longitudinal to best capture changes over time within both the control group and the START-Play group, and to distinguish advances in skill due to the specific intervention (START-Play) vs. general development under the usual model. Recruitment of study participants will be continuous throughout the project's first three years, and assignment to condition will occur at the individual child level. It will not be possible to have a control group without intervention because all recruited children will be delayed enough to have mandated early intervention services. The experimental group will receive the START-Play intervention as well as their regular early intervention services. Randomization is stratified by the severity of neuromotor disorder (mild, moderate, severe). After randomization to group via a computer-generated list, assessment begins.

The assessment schedule covers entry month (between 7-16 months of age) and the following 12 months (between 19-28 months of age). *Five* assessments are done at Baseline, *Mid-treatment*, *final post-treatment testing*, *3 months follow up* and *final Follow-up* (see Table 1). Infants are started in the study on a rolling basis, as they reach the appropriate age and skill level (see entry criteria).

Table 1. Assessment Schedule

Assessment number	1	2	3	4	5	6
Timetable (months after study entry)	0	1	2	3	6	12
Sitting Video Reaching Video	Baseline testing prior to intervention	Rx	Mid Rx testing	Final post Rx testing sitting and reaching	Follow-up	Final Follow-up
Standardized Assessment	Bayley III, GMFM, IGDI		GMFM, IGDI	Bayley III, GMFM, IGDI	Bayley III, GMFM, IGDI	Bayley III, GMFM, IGDI

After the baseline assessment, infants in the START-Play group will begin the intervention *with therapists from the START-Play project trained specifically in the START-Play intervention*, and the infants in the control group will continue with their regular services *with their community service provider*. All infants will receive the same assessments, as well as survey instruments to the families to determine the level of other services received by the infant. All infants will have regular intervention sessions videotaped at least once for quantification of procedures and to assure the fidelity of the intervention being provided across children.

The control intervention is the usual Early Intervention services provided to infants and mandated by public law, which consists of general developmental education and advice and in some cases low frequency therapy. Infants randomized to the intervention group will receive home visits twice weekly for the START-Play physical therapy intervention for three months. *The daily intervention will be provided by the caregiver, based on suggestions from the twice weekly visits of the START-Play therapist*. The START-Play Intervention is designed to advance sitting and reaching, and secondarily improve exploration, manipulation and problem-solving skills. *The START-Play therapy visits will be provided by either the primary investigator or by a consultant therapist (from Children’s Hospital trained and supervised by the PI*. See appendix B in full proposal for examples of START-Play intervention activities.

4. Instruments

1) Primary Measures for Sitting and Reaching

These variables quantify the initial functional delays in these skills and changes during the Intervention and Follow-up periods. *Data will be collected using video by a START-Play assessment therapist and the post doctoral fellow on the START-Play grant (to be hired)*. *Data reduction and coding will take place at various sites, with each site having a focus (Duquesne for kinematics, Delaware for reaching, VCU for problem solving, UW for Bayley and GMFM, UNL for fidelity and overall statistical analysis and data management*.

- GMFM sitting section

The Gross Motor Function Measure (GMFM, Russell et al 1993) is the international standard outcome assessment tool for quantifying change in the gross motor abilities of children with neuromotor disorders (inter-rater reliability, $r=.97$, Russell et al 2000).

Data Collection: The test will be videotaped in the home setting.

Data Analysis: Each sections raw score and % of the section completed will be coded.

GMFM scoring form uploaded.

- Number of toy contacts

Data Collection: Infants are provided six 30 second trials to reach for an object sitting upright on the floor under 3 different levels of support for a total of 18 trials. One of three levels of support are used: at the waist, at the hips, or no support. Trials begin when infants are visually attending to the object. Infants are presented with a graspable toy in midline at chest height 75% of arm length. Two synchronized video cameras assure a clear view for behavioral coding.

Data Analysis: Coders will determine number of toy contacts (and secondary variables, see section below) by coding the videos. Contact occurs when any hand surface contacts the object. Coders are blind to group assignment and study purpose. Coding reliability is assessed on 20% of the sessions and is based on a comparison of agreements and disagreements from each visit. Based on previous work, coders will maintain inter- and intra-rater reliability >90%.

2) Primary Measure for Problem-Solving

- Individual Growth and Development Indicators (IGDIs)

The Infant and Toddler IGDIs are brief psychometrically sound measurements of young children's abilities (Carta et al, 2002) across 4 outcome areas. We have found the Early Problem Solving Indicator (Greenwood et al, 2006) (EPSI) to be sensitive and suitable for assessing infants when assessors are well-trained (>90% agreement). It defines problem solving as consisting of visual exploration, object manipulation and memory. Previous studies show good reliability ($r=.93$) and validity, and its usefulness in documenting change over time.

Data collection: To test, the child is videoed for 6 minutes when presented with standard toys.

Data analysis: Key skill elements are coded for frequency from video. Frequencies are summed, weighted as to complexity of the behavior, and divided by time for a total rate. We will use the certification process online to insure that IGDI testers and coders attain a satisfactory level (90%) of reliability. Members of this consortium piloted the problem solving IGDI on children with neuromotor disorders, creating standardized adaptations for children with limited movement.

3) Primary Measure for Global Development

- Bayley Scales of Infant and Toddler Development—Third Edition (Bayley III, Bayley, 2006), The Bayley III is a well known norm-referenced test designed to assess five key developmental domains: cognition, language, social-emotional, motor and adaptive behavior. Videotapes of this test will be scored to reach reliability of 90% agreement at the UW site.

4) Secondary Measures: These variables quantify factors related to the primary measures above.

Secondary Measures for Sitting related to impairments in postural control:

Trunk alignment as an infant develops sitting posture has long been used as a clinical measure of postural control (McGraw, 1943; Bly, 1983; Harbourne et al, 1993). Movement and posture in sitting will be sampled monthly and quantified with kinematic measures from video.

Instrumentation: Quantification of sitting posture data will occur via a video taken from the side view of the infant (Harbourne et al, 1993). Data will provide:

- angle of forward bending during independent sitting,
- angular velocity and displacement from vertical to self-supported resting position

These variables are indicators of the control the infant is developing for maintaining upright sitting. Standardized positioning of child and camera will allow accurate use of the SIMI Move application to quantify the trunk control in sitting (90% agreement)(Surkar et al, 2013).

Data Collection and Analysis: The infant will be placed in a sitting position on the floor, and supported by the examiner; the examiner then removes their hands, which have been supporting the trunk. Measurement is taken from the point of the initial supported position to the end position independently assumed by the infant, and is quantified by degrees. Data are collected for 3 trials while the child attempts to maintain sitting. *See Appendix A.*

Secondary Measures for Reaching (documents impairments in reaching and object exploration):

These variables are coded from video to further quantified reaching:

- Age of reach onset and number infants that are reaching at each age. An infant is ‘reaching’ the first session he contacts the toy more than 5 times in 3 min of trial time (Lobo et al 2004).
- Percent of time each hand is in contact with the toy (aka Contact Duration).
- Number of toy contacts with both hands
- Hand position at initial contact and during contact: open/closed hand, ventral/dorsal surface.

Secondary Measures: Child and Family Characteristics

Child characteristics (Severity, Cognitive, Age, Health) will be recorded, respectively, from a Severity Index, Bayley III scores, and a Demographic questionnaire and Health questionnaire, which are both completed by parents. Environmental factors include: 1) Parent/child interaction (PCI-DMC) See Figure 1, Appendix C., 2) Home environment (HOME scale [Elardo & Bradley, 1981]), 3) Socioeconomic status (SES), 4) program attendance/participation (visit counts), and 4) overall amount of services (Therapy Services questionnaire). The Home Observation for Measurement of the Environment (HOME) Inventory – Infant/Toddler version assesses the home environment including adult/child contact, social/cultural experiences, physical environment, and access to toys. SES will be measured on a Demographic questionnaire completed by parents. Program attendance will be recorded by the number of accomplished visits, documented by the therapist visiting the home. Amount of therapy recorded on the Therapy Service questionnaire completed by parents(Appendix C).

Our fidelity approach will determine the degree to which all elements of the START-Play intervention are delivered across treatment and control conditions (Knoche et al, 2010). We will assess dosage, adherence, quality, participant responsiveness, and program differentiation (Berkel et al., 2011; Cordray & Pion, 2006; Dane & Schneider, 1998; O’Donnell, 2008) with three primary measures: (1) START-Play Home Visit Coding Guide (adapted from the Home Visit Observation Form; McBride & Peterson, 1997) (see Appendix C); (2) Therapy Services Form (adapted from Westcott & Effgen, 2011; Appendix C); and (3) Home Activity Log (Appendix C). Both the experimental and control groups will be measured using these instruments.

5. Sample selection and size

Infants (n=42) with neuromotor disorders will be randomly assigned to either the experimental intervention (START-Play Intervention) or to a control group between 7-16 months of age depending on motor skill readiness for sitting and reaching activities. We expect a 10% drop-out rate in this longitudinal study, for a final number of 38 children at our site, 19 in each group. Power analysis was conducted for this multi-site trial on pilot data for each variable, and N=152 (4 sites, 38 each), with 93%-99% ability to detect true difference in our primary variable.

Inclusion criteria:

- Infants enter study between 7-16 months of age, when they are able to prop sit for 3 seconds and maintain their head to the level of neutral alignment with their trunk.
- Gross motor delay as scored on the Bayley III motor subtest >1.0 SD below the mean.
- Neuromotor disorder such as cerebral palsy (CP), or at risk for CP because of extreme prematurity or brain damage that occurred at or around birth, or infants with motor delay of an unspecified origin (no clear diagnosis, but delay as above)
- Eligible infants may meet the U.S. federal criteria for children with disabilities in one of the following categories: orthopedic impairments, multiple disabilities, other health impairments, or developmental delay.
- Minimal movement requirements/Indicators of readiness for change: Sits with support of arms for 3 seconds after being placed. Exhibits minimal spontaneous movement of arms.

Exclusion criteria:

- *Medical complications* that severely limit participation in assessments and intervention such as severe visual and congenital/genetic anomalies, uncontrolled seizure disorder.
- Diagnosis other than an unchanging neuromotor disorder (examples: autism, Down syndrome, spinal cord injury, acquired head injury, muscle disorder).

A child will be excluded if the parents report any of following: 1) if the child has a disability of a progressive nature such as muscular dystrophy; 2) if the child's family plans to move out of the local area within one year from the start of the study; 3) if the child has major surgery planned.

6. Recruitment of subjects

Infants will be recruited from Children's Hospital of Pittsburgh centers and follow-up clinics, local Early Intervention (EI) programs, and local EI therapists. Flyers (attached) will be provided to these centers with contact information of the PI (Harbourne) for interested families. Any information provided to clinics or therapists will indicate that participation in the study is voluntary, and that families will be paid a small honoraria (total of \$100) for participation in the multiple sessions, and infants will be provided small gifts.

7. Informed consent procedures

During the first contact made with the infant and family, written information explaining the study will be provided that explains in simple terms, a) criteria for participation, b) purpose of the research and procedures involved, c) the families right to withdraw the infant at any time without penalty of any kind, d) assurance of anonymity (via number representation vs. name). If the infants meets the inclusion criteria and not the exclusion criteria, and the family is interested, the information just described will be reviewed, questions will be answered and an informed consent will be signed in the presence of a designated research personnel and witness. Families will be reminded that this signature does not bind them to participate and that they are free to withdraw at any time without providing a reason.

8. Collection of data and method of data analysis

All infants (*both groups*) and their families will participate in assessments starting at 7-16 months of age and continuing for 12 months. *The five assessment sessions are in addition to the intervention sessions, and will be done in the home.* The control intervention is the usual Early Intervention services provided to infants and mandated by public law, which consists of general developmental education and advice and in some cases low frequency therapy. Infants randomized to the intervention group will receive home visits twice weekly for physical therapy intervention for three months. The START-Play Intervention is designed to advance sitting and reaching to improve problem-solving skills (see Appendix B for examples of intervention). Each participating site will analyze a specific part of the video or survey data: Bayley test & GMFM, UW; IGDI & PCI, VCU; Reaching variables, UD; Sitting variables, Duquesne University; Fidelity, factors external to the child, and statistical analysis, UNL. UNL will house all data and create/maintain a data sharing system whereby all sites can securely upload, download, store and share videos from all sites, using password protected access to the UNL server.

9. Emphasize issues relating to interactions with subjects and subjects' rights.

The START-Play Intervention is low risk. Specifically, this intervention consists of play activities that are developmentally appropriate for young infants and are supervised by family and therapist. Families and therapists work together to select the activities, and families are provided education on progressing their infants to more challenging and fun activities. The risk of participation is no greater than during typical floor activities between an infant and family. Risks are minimized by having families and investigators within arm's reach and focused on the infant at all times. The infant is never left unattended.

Assessments completed during home visits involve typical activities of infants such as sitting, rolling and reaching. The risk of participation is no greater than during typical floor activities between an infant and family. Videos obtained of these assessments will be sent to a central data management site (UNL) and made available to all the sites for scoring at each site on specific variables. These videos will not include identifying information, and will have a code and no names. The identifying information will only be available to the primary investigator at each site, and will be kept in a locked file. Families will be offered electronic copies of any video of their child that they want.