Pediatric Wheeled Mobility

"Enabling Children to Explore, Play and Satisfy their Curiosity"

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Background

- **Previous research has found independent movement is extremely important in a child's development and can facilitate cognitive, psycho-social and language skills**

  Campos, Bertenthal, Erikson, Piaget, Kermonian

Limited mobility experiences and psychosocial development

- **Environmental Deprivation**
- **Sense of identity**
- **Isolation/Depression**
- **Restricted Mobility: learned helplessness, decreased motivation**
- **Potential causes for cognitive, perceptual delay and spatial development**

Zubeck J (1963),Tatlow (1980),
Brinker (1982), Verburg (1987)

Mobility and Visual Development

Independent movement facilitates visual development through:

- **Cortical development**
- **Spatial relationship comprehension**
- **Depth perception**
- **Vestibular information**

Restricted Mobility in Play

- Less co-operative play
- Lower status/passive role
- Observer

Leads to frustration, apathy, decreased social development, self-esteem and identity formation

Tamm M, Skar L. (2000)

Demands of Ambulation

- **Pathological gait patterns increase muscular demands and energy expenditure**
- **Energy cost of walking taxes ability to concentration in school**
- **Ability to ambulate declines as child grows older and heavier**

Waters et.al. (1983), Franks et.al. (1991), Rose et.al. (1989), Wiart et.al. (1999)

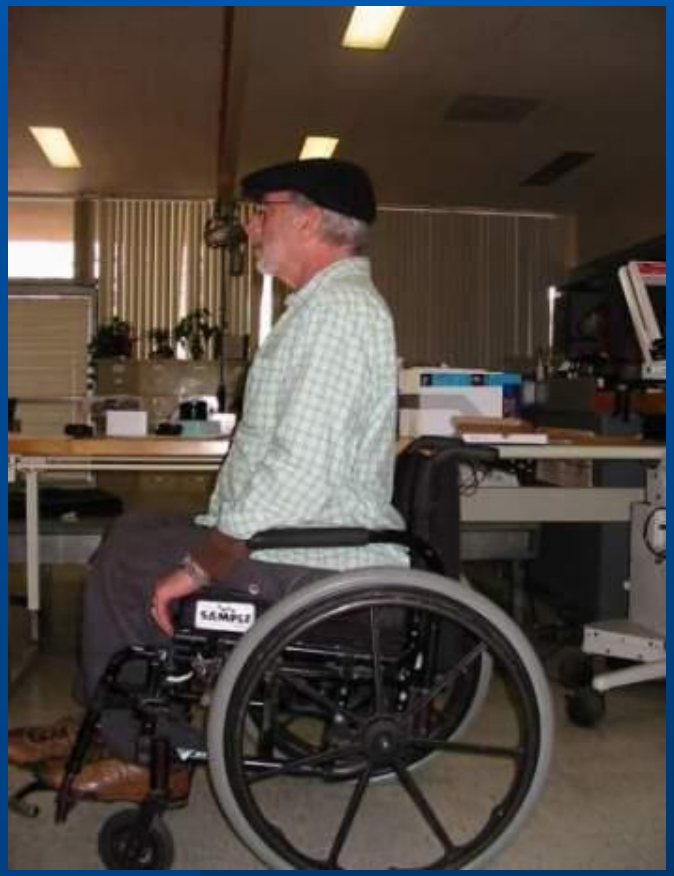
Demands of Manual W/C propulsion

- **Manual w/c propulsion requires higher O2 consumption than ambulation in typical child**
- **W/c size, shorter UE and similar issues compromising gait also affect ability to propel efficiently**
- **Age and environmental demands**

Optimal Wheelchair Configuration

- Upright Pelvis/trunk
- Backrest: perpendicular to floor, height below the scapula
- Adjust the rear axle forward 2”
- Position the rear-axle so that the upper arm and forearm angle:100 -120 degrees. “10-2” propulsion pattern

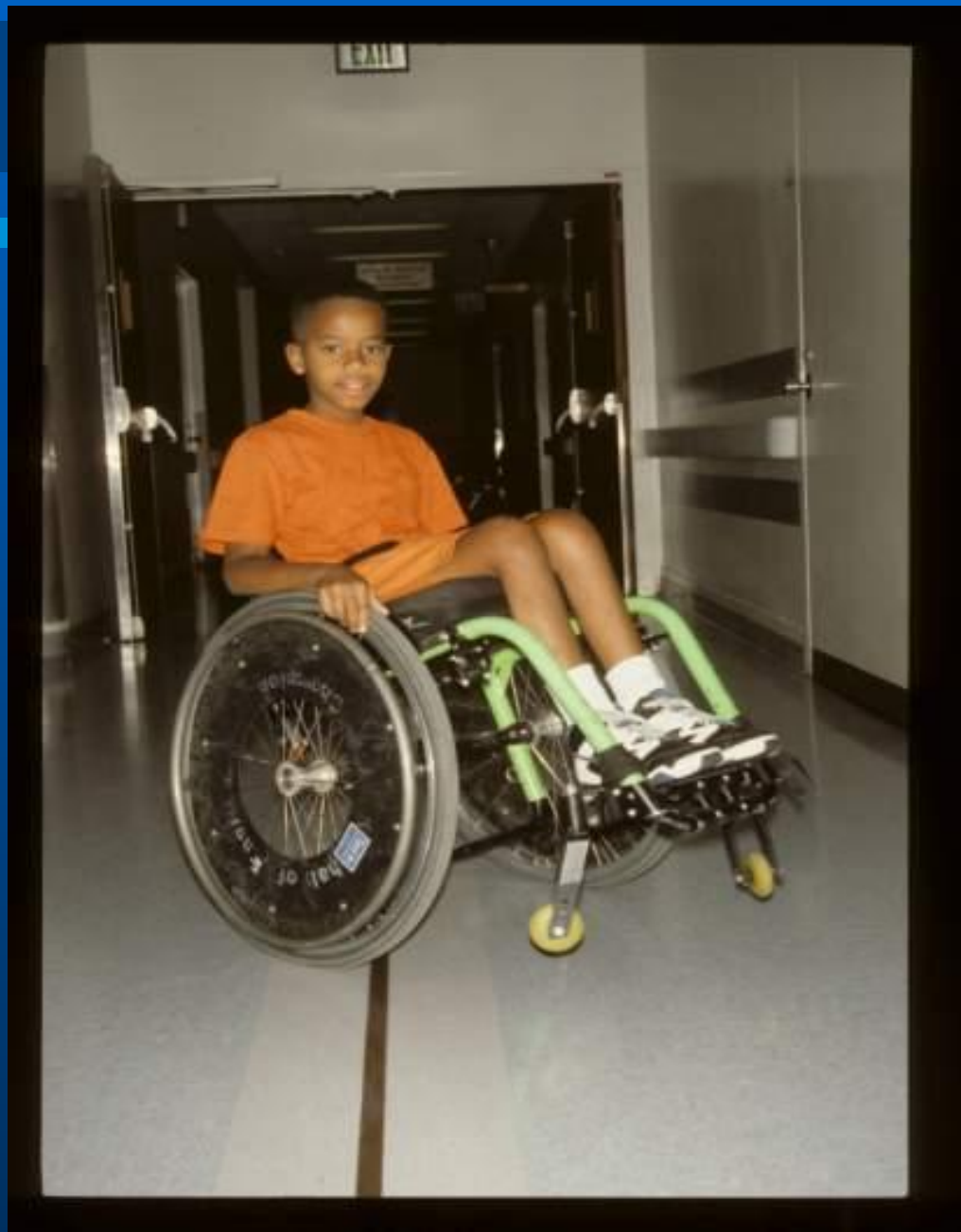
Wheel Axle placement



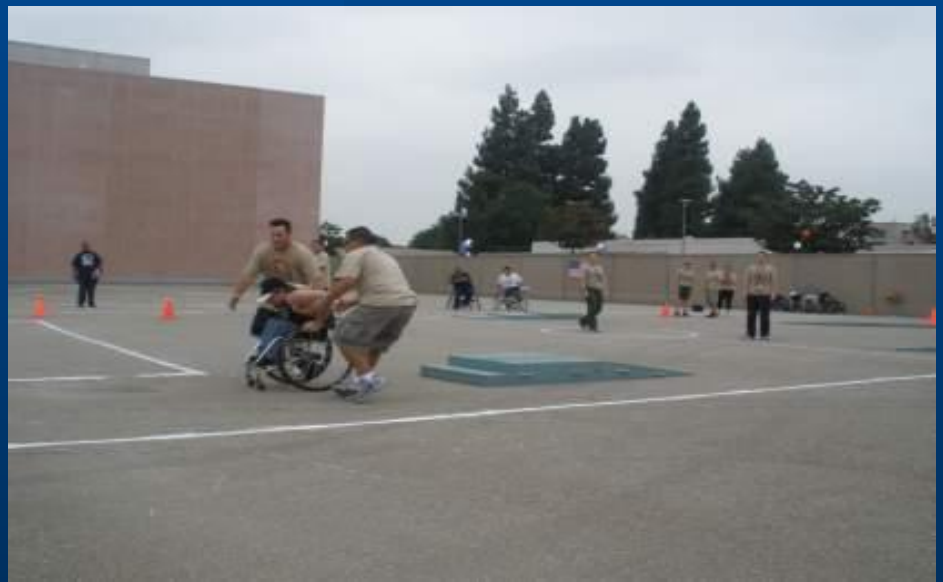
Wheel placement

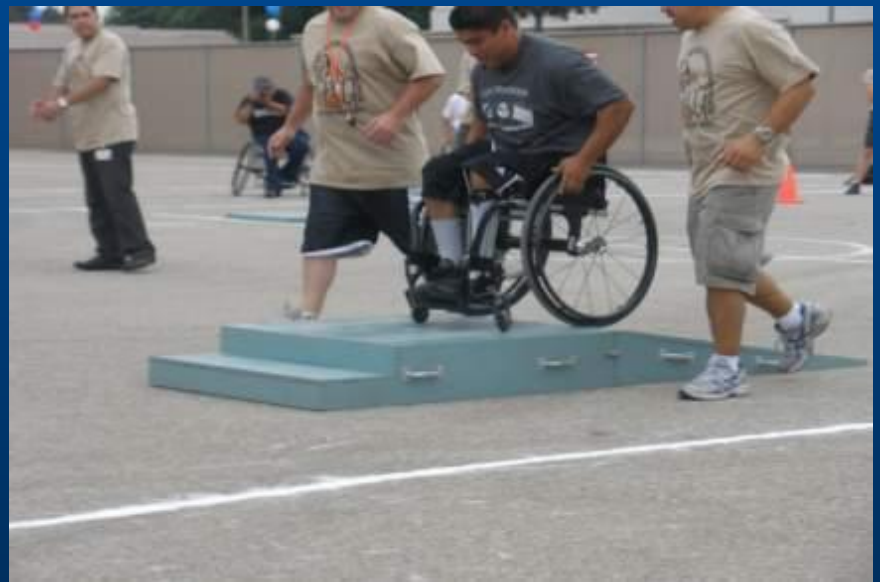
“Wheelie Test”

- **Have patient pop a wheelie. Want the front casters at least 1” off of the ground.**
- **If front casters are greater than 4” off of the ground, then the axle is too far back.**

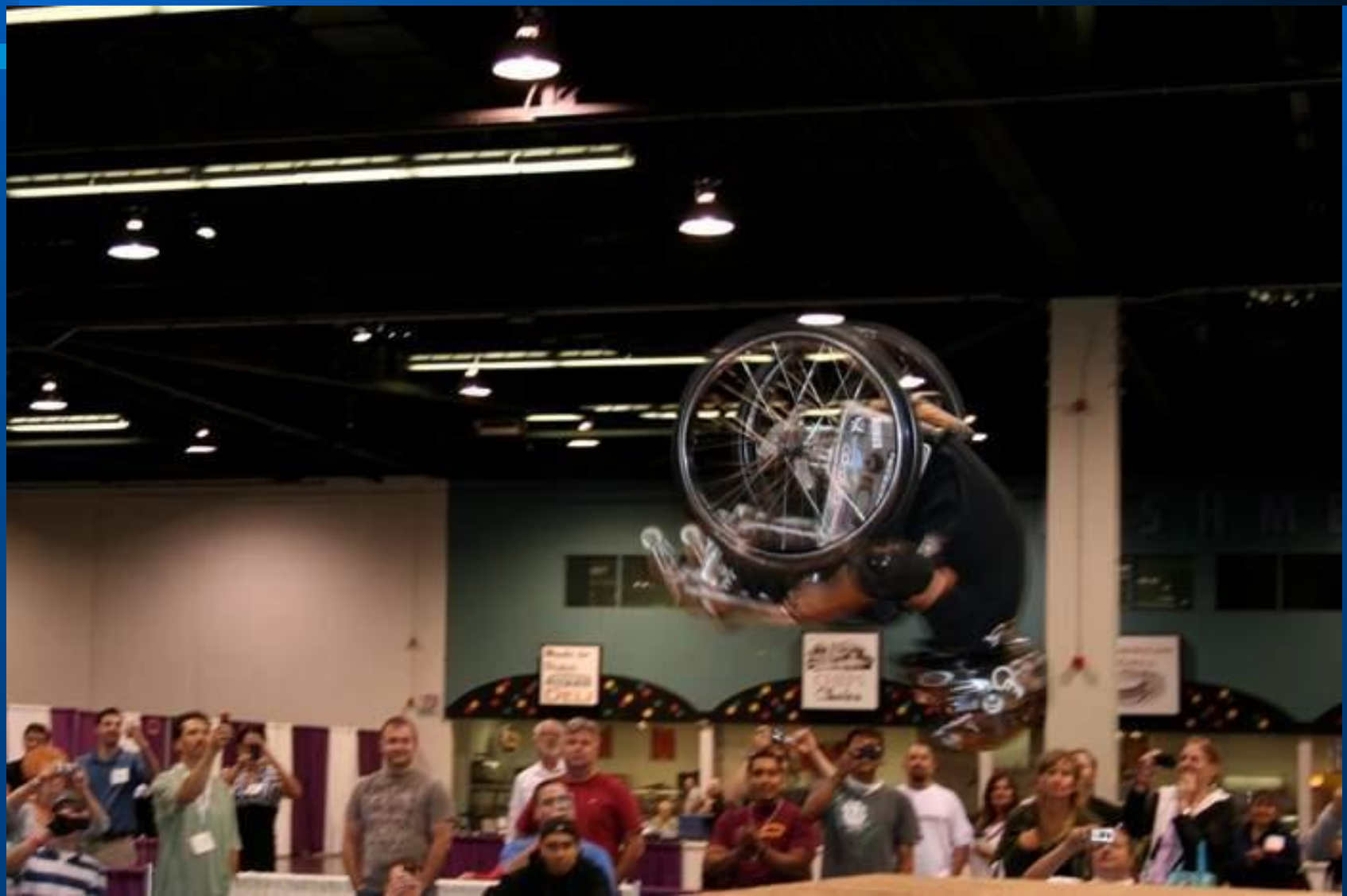


Wheelchair skills





Suspension Wheelchairs



Power Assist wheels

Energy Consumption

	Rate of O2 consumption	Oxygen cost	Heart rate
Standard w/c	8.4 ml/kg min	.11 ml/kg m	82
I- Glide	6.9	.11	72
Xtender	6.7	.07	75
E-motion	6.2	,08	78

Clinical application of the Dynamic Systems Theory in pediatric mobility

- **Task accomplishment by most efficient strategies available in order to explore their environment and participate in meaningful activities**

Wiart L, Darrah J, 2002

Functional Independent Early Powered Mobility

- Has positive impact on psychosocial skills
- Reduces learned helplessness and increases confidence, cooperation, and interactions with others
- Improves quality and quantity of play skills with peers and family

"Mobility must be functional so exploration can be spontaneously initiated and successful"

C. Butler, 1984

Stages of Mobility development are related to stages of Cognitive Development

Tefft, Guerrette, Furumasu 1996

Factors That Affect Powered Mobility

- **Physical access**
- **Cognitive readiness**
- **Temperament**
- **Dynamic integration of sensorimotor processing**

Objectives – Project I (1990-95)

- Develop cognitive assessment battery for children with physical disabilities
- Develop powered mobility skills list and objective scoring scale
- Document relationship between cognitive skills and powered mobility skills

Demographics of Participants (N = 26)

- Diagnoses
  - Arthrogryposis (9)
  - Muscle Disease (9)
  - SCI (3)
  - Other (5)
- Gender
  - Male (20)
  - Female (6)

Demographics

Age range

- **18 – 26 mos (8)**
- **27 – 30 mos (10)**
- **31 – 36 mos (8)**

- **Mean age = 28.9 mos**

Assessment Battery Requirements

- **Piagetian, criterion based**
- **18 - 36 month age range**
- **Flexible administration procedures that do not penalize motor limitations**

Piagetian-Based Domains

A total of 83 items evaluated the following domains:

- Cause and Effect
- Object Permanence
- Problem Solving
- Spatial Relations
- Symbolic Play

Stages of Development

- SM V (12-18 mos) Trial and Error
- SM VI (19-24 mos) Insight/Symbolism
- PO (25 - 42 mos) Problem solving

Power Mobility Program (PMP)

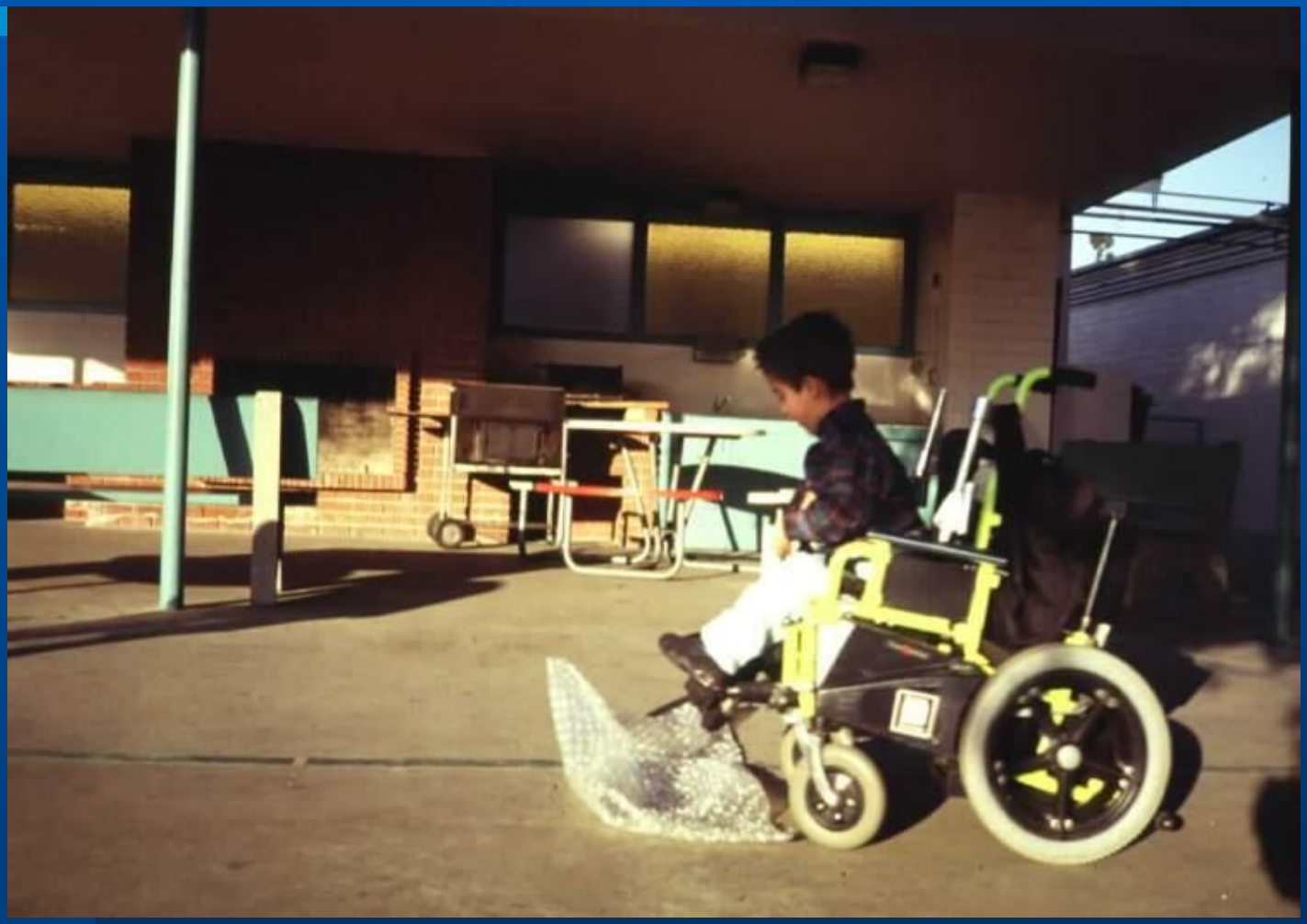
- 17 Basic/Exploratory Skills

starting/stopping, directional and speed control

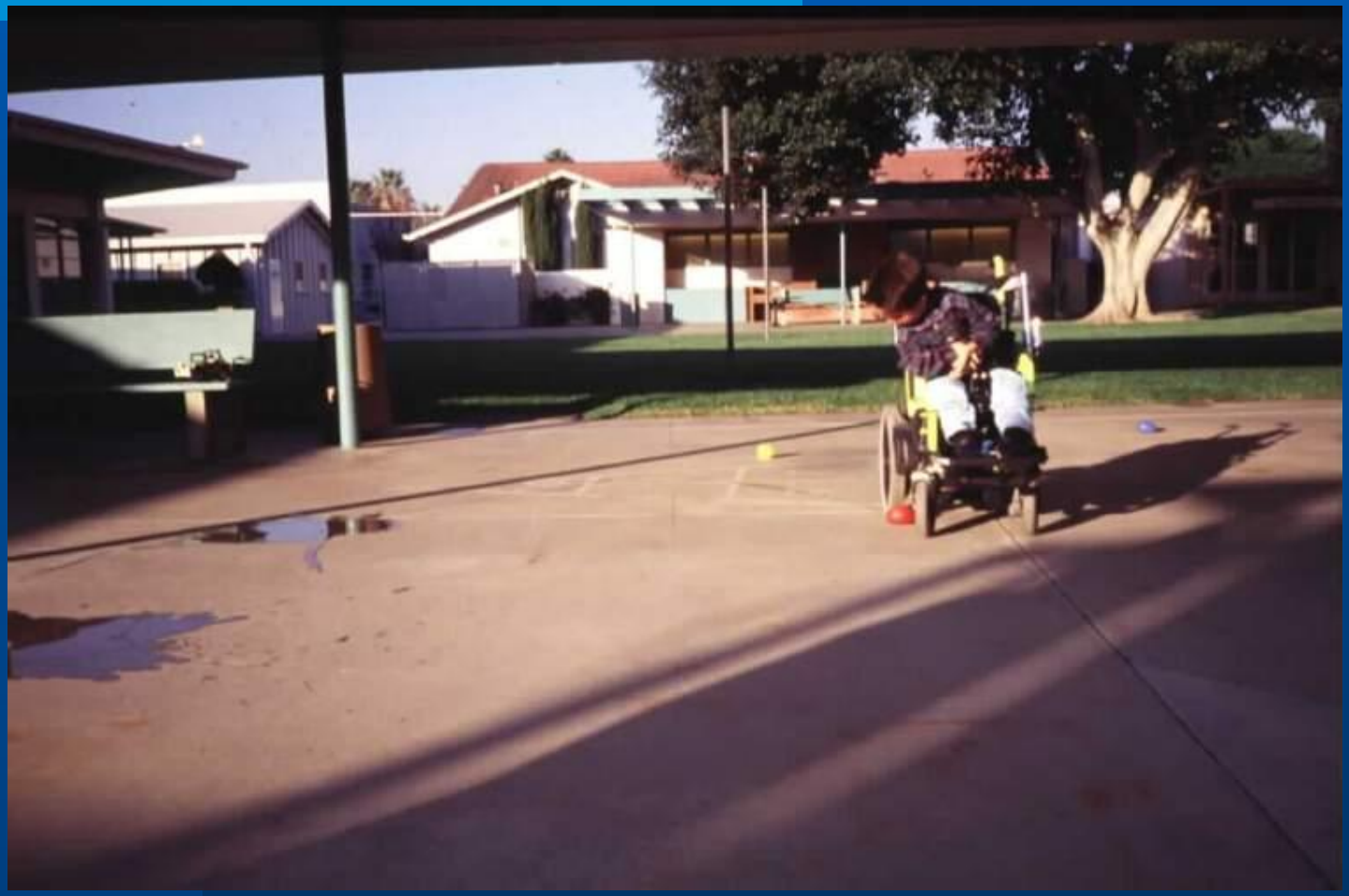
- 17 Functional Mobility – Structured and unstructured environments

doors, hallways, sidewalks,ramps etc

Motivational Learning through Play



Motivational Play and Exploration



PMP Scoring

- 0 -- Task not attempted
- 1 -- Maximal assist of joystick
- 2 -- Minimal assist of joystick
- 3 -- Direct stand by guarding with verbal cueing
- 4 -- Verbal cueing only
- 5 -- Age appropriate supervision

PMP Scoring

Score	Amount of Assistance	# Children
0 - <3	Maximal to minimal hands-on assistance	15
3 - <4	Stand-by assistance	2
4 - 5	Verbal cueing to age-appropriate supervision	9

Regression Analysis

Used to determine the cognitive factors that predict powered mobility driving performance

Spatial relations and *problem solving* were significant ($p<.05$, $R^2= .57$)

Cognitive Levels

Basic Skills:

- **Problems solving = 20 mos**
- **Spatial relations = 25 mos**

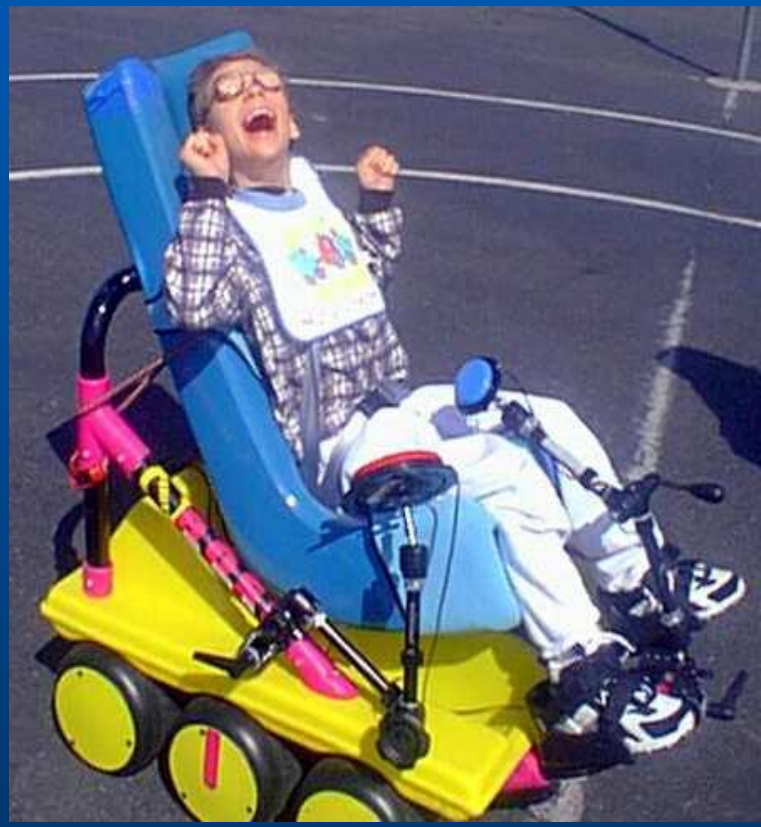
Functional skills:

- **Problem solving = 30 mos**
- **Spatial relations = 25 mos**

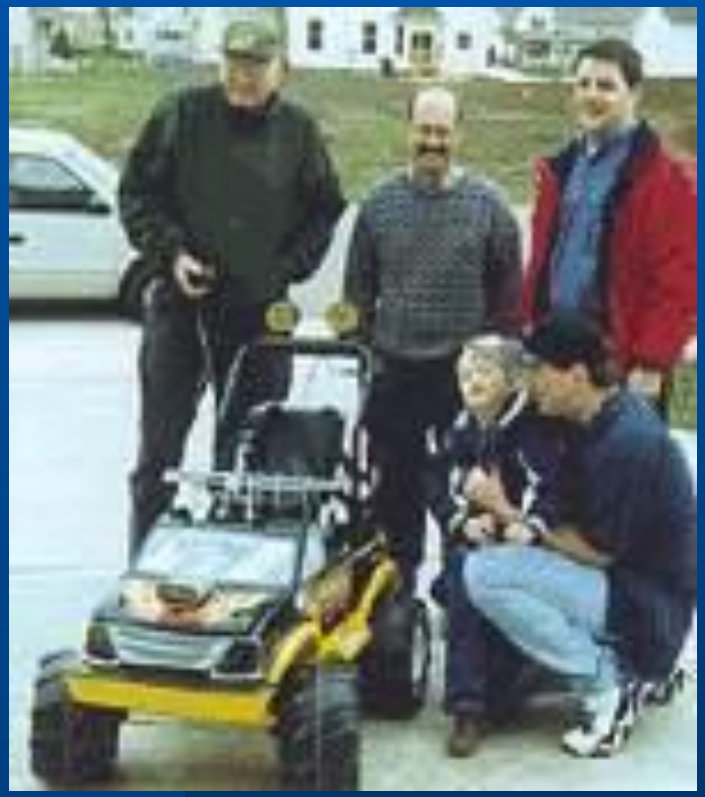
Cutoffs yield sensitivity = 1.0, specificity = .80

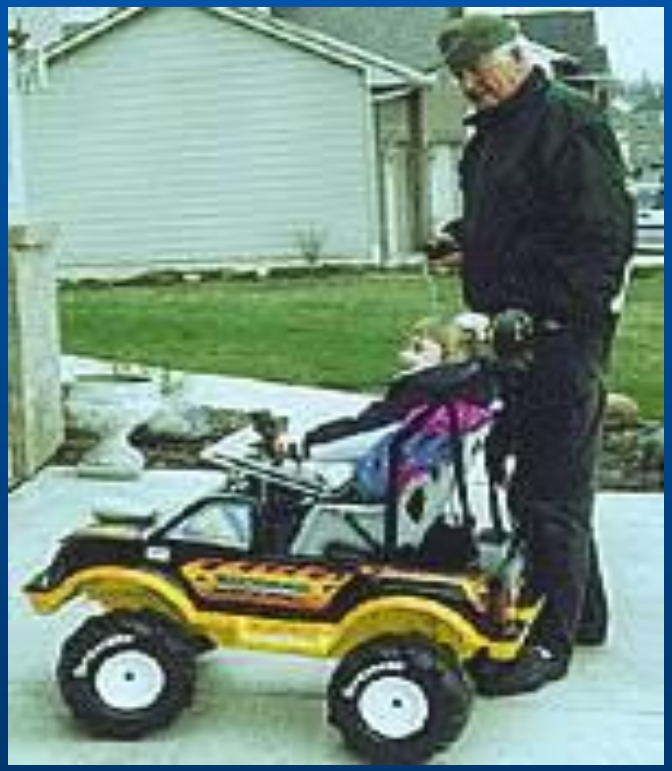
Pediatric Powered Toys

- Go KART, Sit to stand Innovative Designs: www.iphope.com
- Cooper Car: www.rjcooper.com/coopercar
- Adapting power toys: www.tetrasociety.org/project_pages/modified_childrens_vehicle.htm
- www.scienceshareware.com/toys.htm



Modified Power Toys





Powered Mobility and Young Children With Disabilities: A Multicenter Trial

Project II (1996-2000)

Funded by NIDRR, Dept of Education

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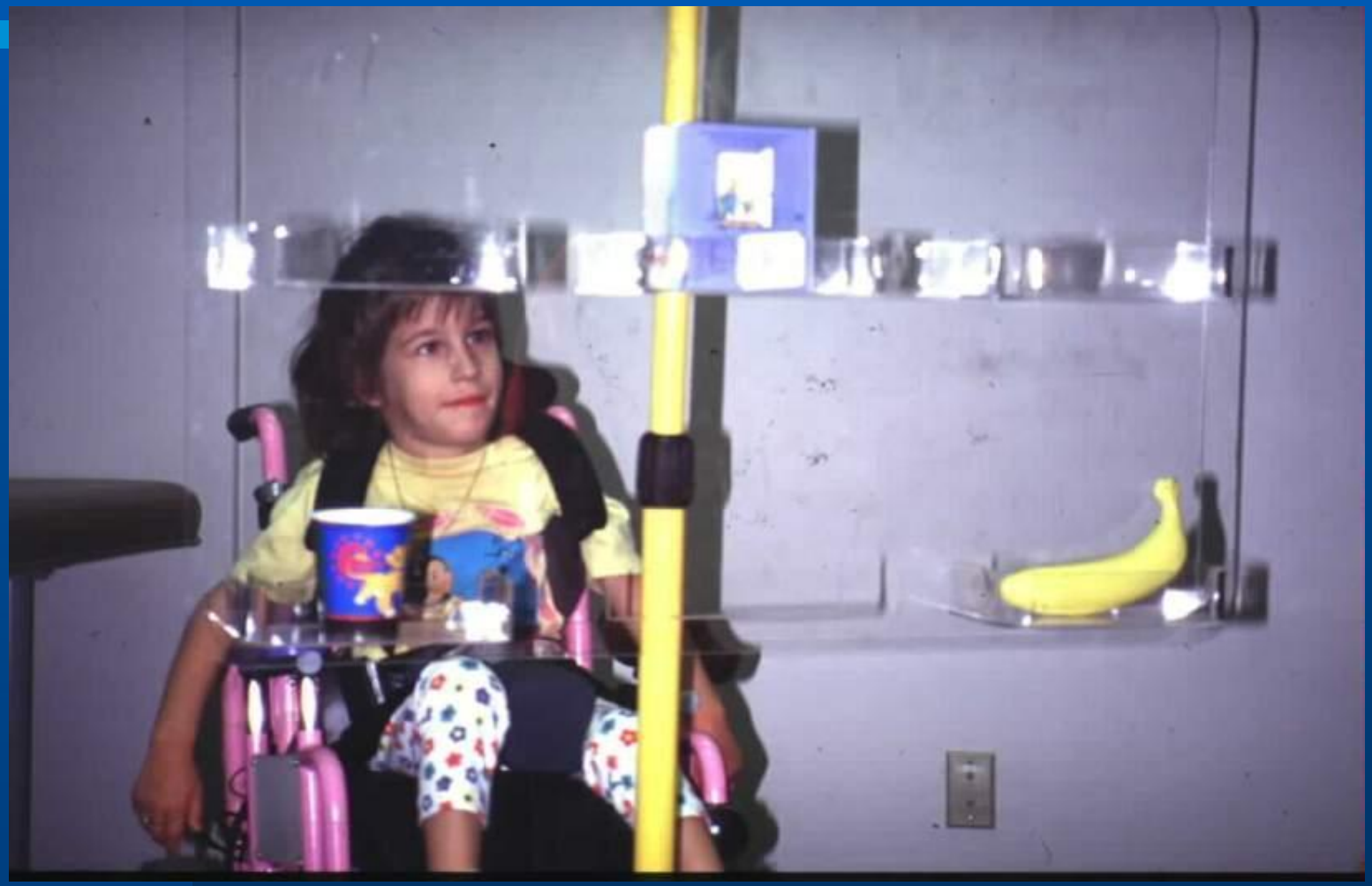
Objectives – Project II

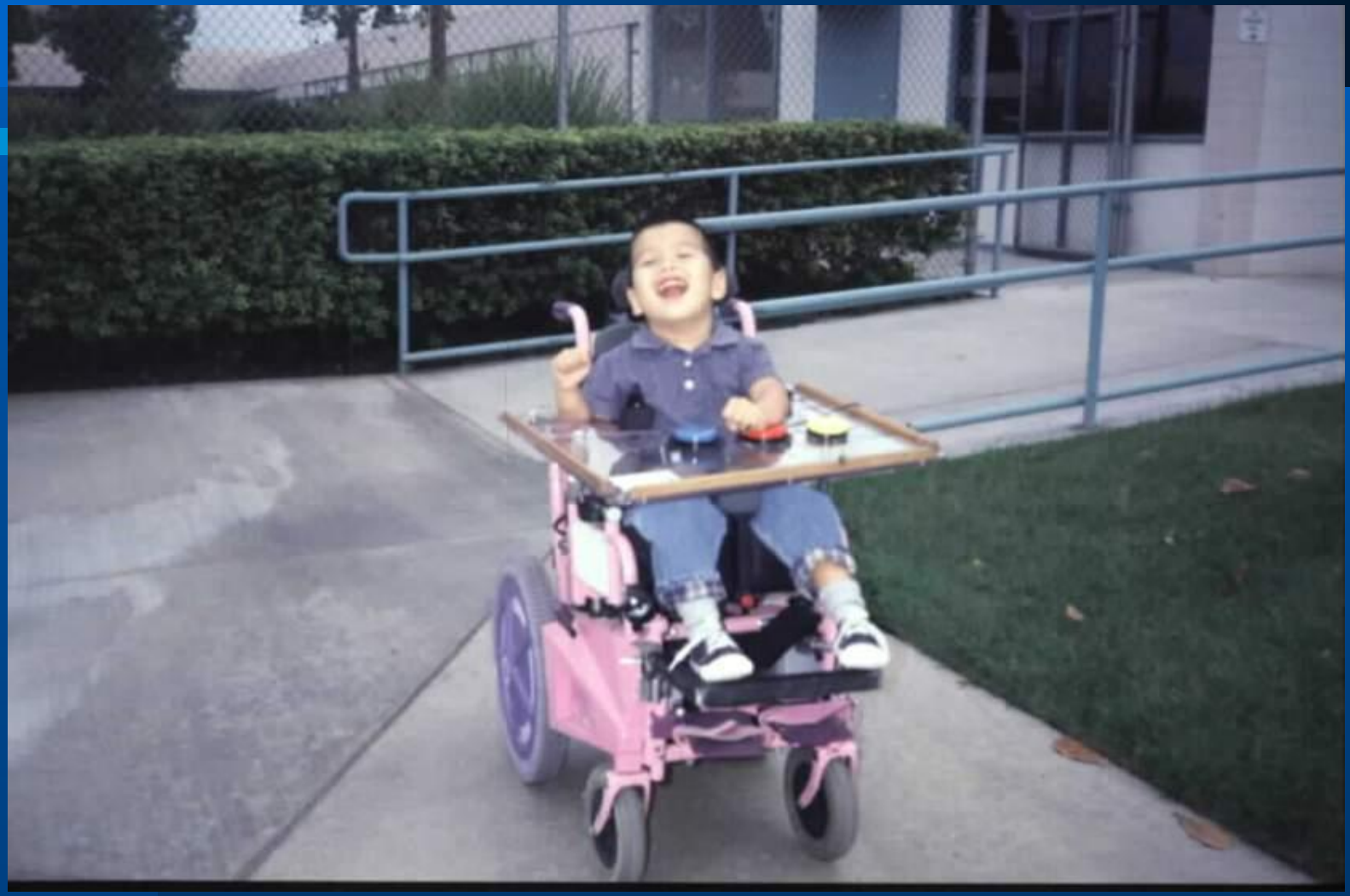
- Explore applicability to children with CP
- Determine if assessment of other factors (i.e., coping skills, level of symbolic representation) can increase predictive power of PPWST
- PPWST applicable to switch users. (modify PPWST for Yes/No and eye gaze responses)

Symbolic Representational Scale



Children Tested (N = 50)

- Children with orthopedic disabilities (N = 24) -- 18-36 mos
- Children with CP (N = 26) -- 2-6 yrs
- Either joystick or switch access



Regression Analysis
by Access Type

Group	N	Significant Factors	R^2
Joystick	35	SR, PS	74.1
Switches	13	PS	19.7

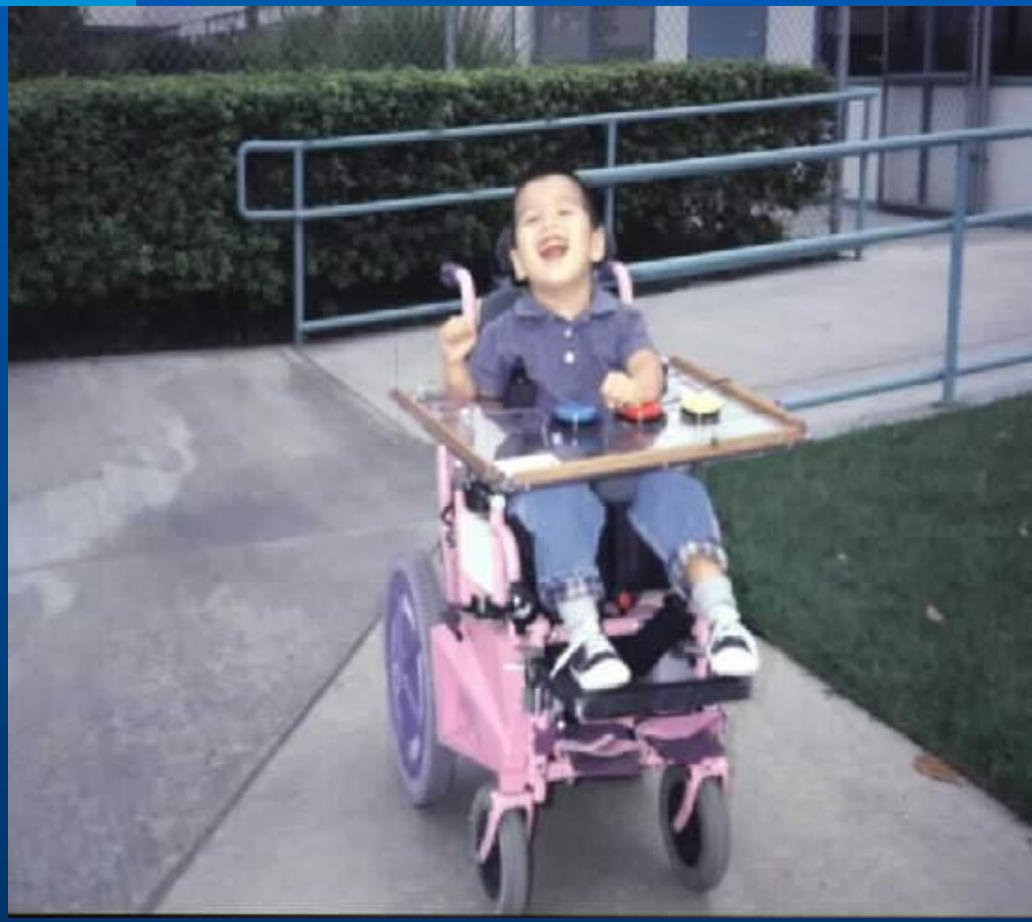
Results

Spatial Relations and **Problem Solving** were still highly predictive of W/C Skills

- PPWST is valid screening test for children who use joysticks but not switches, regardless of disability.
- Symbolic representation only slightly increase variance accounted for in w/c driving for children with CP w joysticks.
- Coping was not significant

Areas of Development

- Motor access
- Problem solving/spatial relations
- Sensory/motor integration
- Safety judgment



Development and Evaluation of a Model for Provision of Powered Mobility to Young Children

Project III (2000-2005)

Funded by NIDRR, Dept of Education

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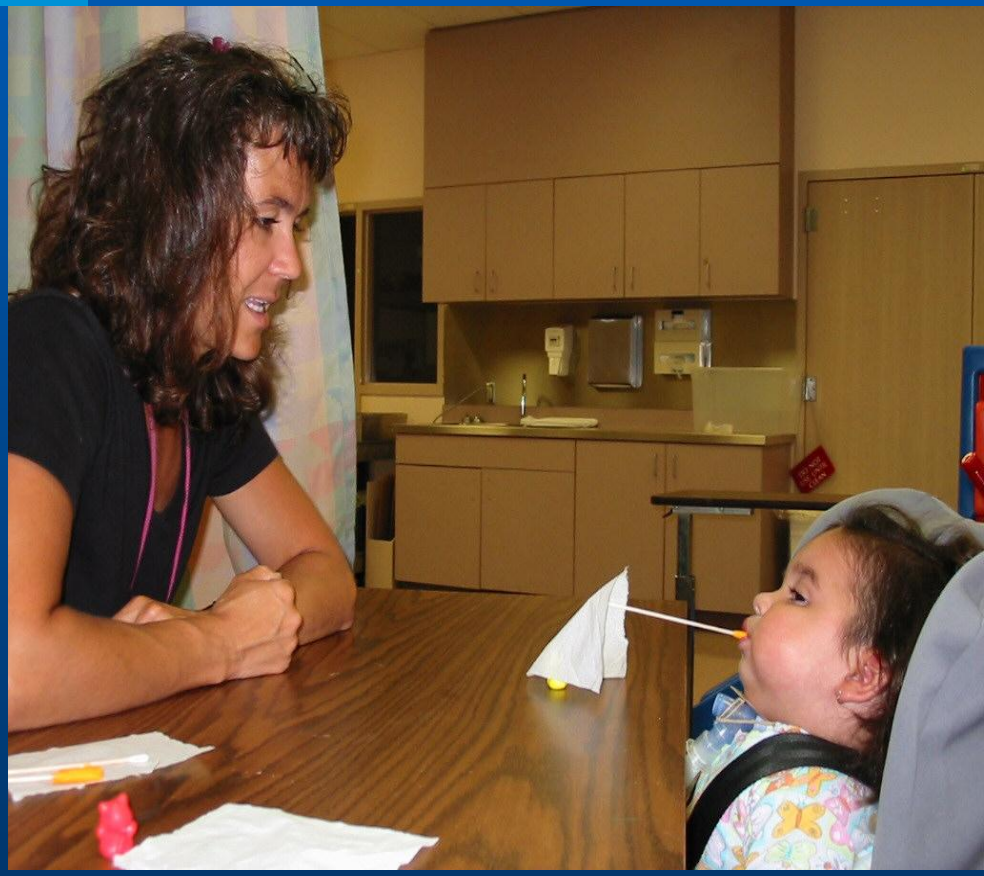
Objectives – Project III

- Conduct national survey to describe existing models of practice
- Collect outcome data on children who have had powered mobility to document benefits

Survey: Reasons W/C Not Recommended

- **Cognitive factors 41%**
- **Physical factors 17%**
- **Behavioral factors 13%**

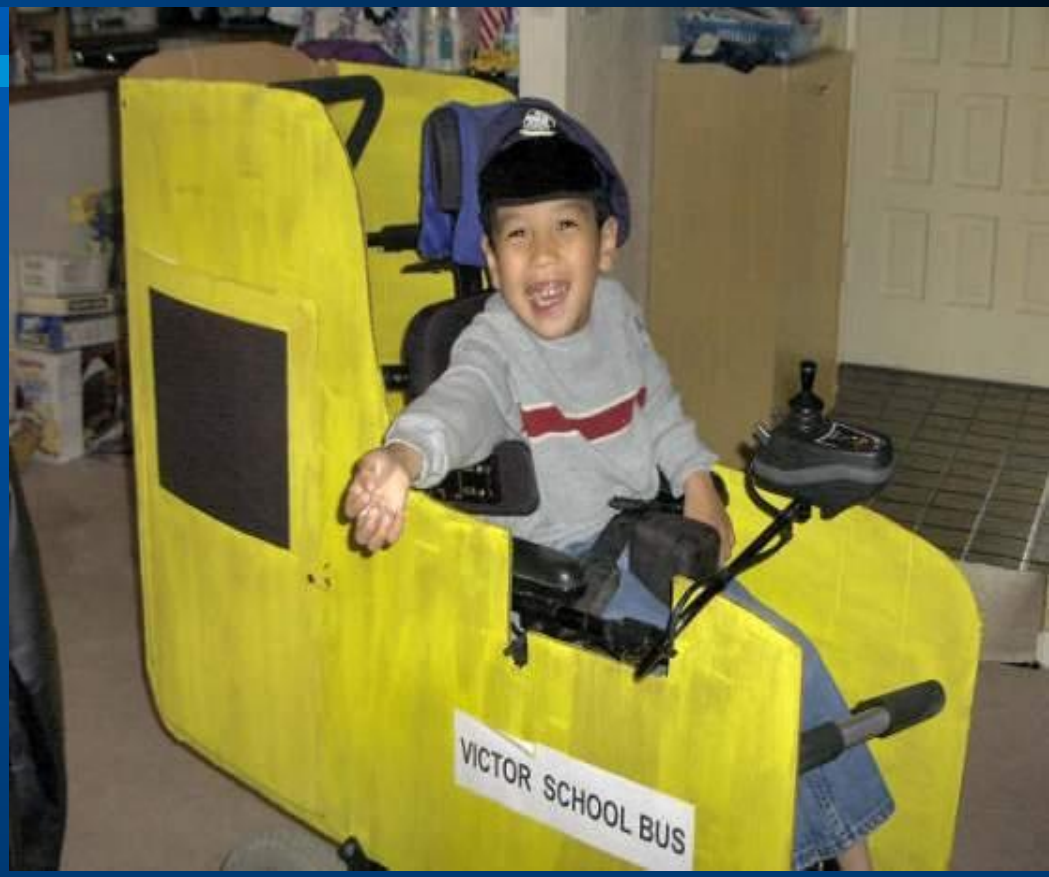


Survey: Reasons W/C was NOT Received

- **Funding Issue 39%**
- **Lack of family support 22%**
- **Transportation Issues 18%**

Purpose: Outcome measures

To determine the impact of early powered mobility on children's cognitive, psycho-social and play skills



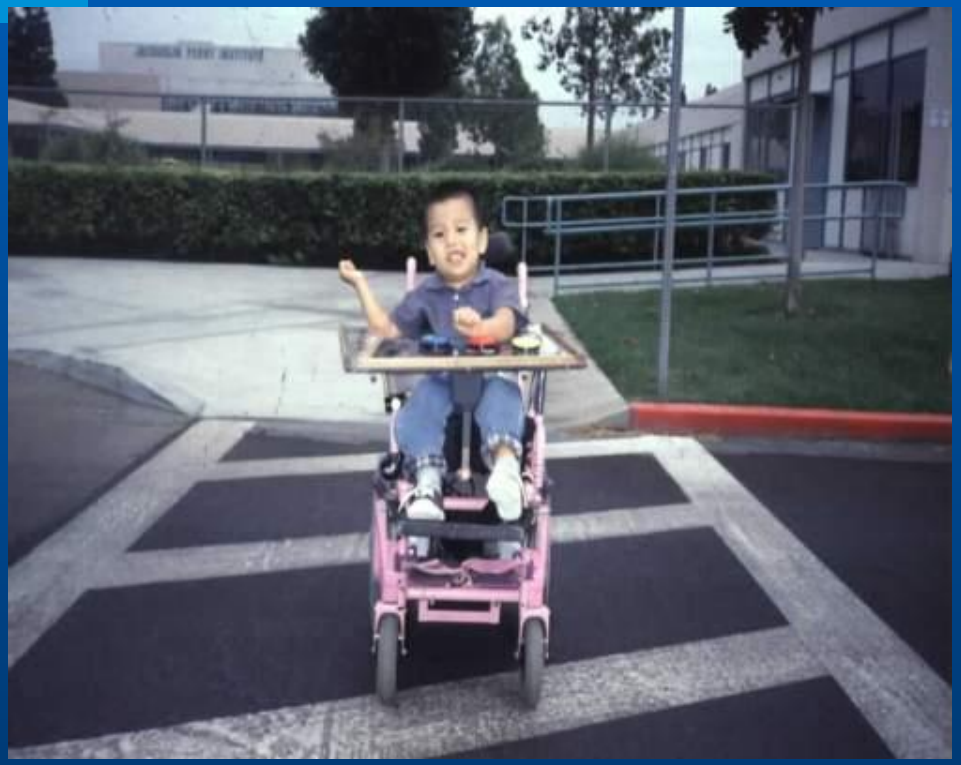
Background

In children with cerebral palsy, use of a powered W/C was found to. . .

Improve parental perceptions of child's behavior and disposition in the w/c

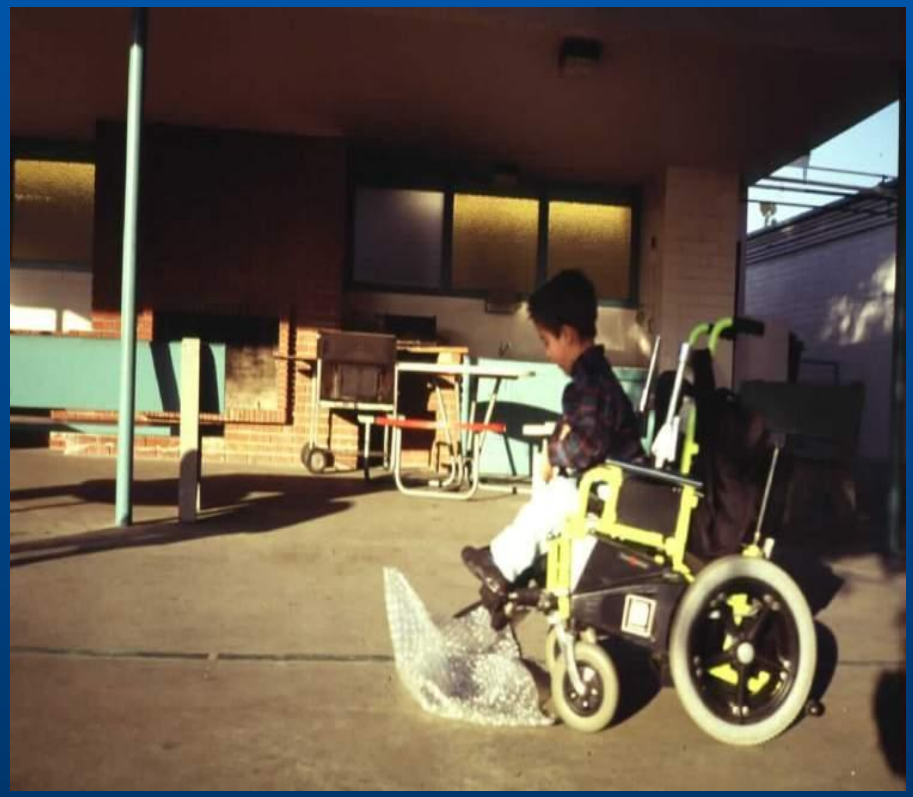
Did not affect gross motor function

Bottos, et.al., 2001



Procedure

- 23 /56 children who received power w/c
- 1st pre-test at time of eval
- 2nd pre-test time of delivery (4-6 mos)
- 3rd post-test (4-6 mos)



Results

Social Skills

Adaptive Social Behavior Inventory

'Prosocial' component (understands others' feelings, cooperates, plays w/ other children) improved from pre to post-test ($F=5.30$, $p<.01$)

Preschool Kindergarden Behavior Scales

- No difference found in negative/disruptive behaviors
- Positive social skills (cooperation, interaction, independence) improved from pre1 to pre 2 ($F=6.14$, $p=.009$)
- No difference in negative behaviors

Results

Survey of Technology Use

- **Ability to remain engaged was significantly different from pre to post-test ($F=3.60$, $p<.05$); child needed more prompting to remain engaged**
- **Interactions with family significantly increased ($F=4.53$, $p=.04$) from pre- to posttest**
- **Significant increases seen in self-esteem, self-confidence, composure from pre1 to pre2**

Results

Play Skills

- ***Observational Play Scale***
  - **Increase in motor activities during indoor play (F=4.53, p<.02)**
  - **Increase in quality of interactive play (F=3.52, p<.04)**
- ***Symbolic Play Scale***
  - **Developmental level of play** improved significantly **after acquiring powered wheelchair (F=4.9, p<.02)**
- ***Language development***
  - **Preliminary results show no significant changes from pre- to post-test**

Summary

- Positive impact psychosocial skills (improvements found in confidence, cooperation, interactions w/ others)
- Improvements in play skills
- Preliminary results did not find differences in language development

RESNA Position paper on Pediatric Powered Mobility

- **Recommends the early utilization of powered mobility for appropriate candidates as medically necessary to promote integration, psycho-social development, reduce learned helplessness and enhance independence.**

RESNA Position paper on Pediatric Powered Mobility

- **Age, limited vision or cognition, behavioral issues, the ability to walk or propel a manual w/c short distances should not be used as discriminatory factors against Powered Mobility**

Smart Wheelchairs

Training Developmentally Disabled children to use Powered Wheelchairs

CALL Centre, University of Edinburgh, Scotland, 1992

University of Irvine, California, 2009

Robot assisted powered mobility

- RESNA Position paper on pediatric powered mobility: www.resna.org
- Pediatric powered mobility projects: www.ranchorep.org/pm
- jfurumasu@dhs.lacounty.gov